# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

---

**APRIL 1905.**

---

## GENERAL PHYSICS.

665. *Simple Instruments for the Exact Determination of Time.* **G. Guglielmo.** (Accad. Lincei, Atti, 13. pp. 603–611, Dec. 18, 1904.)—The writer refers to the usual method of determining by means of the sextant the time of passage of a star across the meridian. This coincidence of the two images observed by this method is when the altitude of the star is equal to the angle between the mirrors, or twice that angle when the natural horizon is used, and the mean of the times of the two contacts by the chronometer gives the exact time of the passage of the star, the difference between the time so calculated and that given in the nautical almanac being the error of the chronometer. In this paper, after pointing out the disadvantages attending the above method, he describes a method of observation in which the angle between the mirrors remains unchanged. The time of passage, and by consequence the error of the chronometer, having been determined for any one day, the times of the two contacts for that day are known, and can be found for earlier or later days by adding or subtracting $8^{m}\ 55{\cdot}9^{s}$ per diem, that being the correction for sidereal time. He describes, in theory only for this paper, an instrument in which a prism is used for the two mirrors, insuring the invariability of the angle between them [see next Abstract]. S. H. B.

666. *Simple Instruments for the Correction of a Clock.* **G. Guglielmo.** (Accad. Lincei, Atti, 14. pp. 10–17, Jan. 8, 1905.)—Several instruments are described. The first is a horizontal telescope with a prism placed in front of the objective, the axis of the prism being horizontal and at right angles to that of the telescope. The object, for example a star, is seen by direct reflection at the upper face of the prism, and also by reflection at an artificial horizon of mercury and the lower face of the prism. When the two images coincide, the angle of the prism is equal to the altitude of the star. By observing the times at which the star has the same altitude, east and west of south, the instant of southing is determined. The sun may be used in a similar manner, and the author describes a method in which the telescope is dispensed with, the images of the sun being produced by a small aperture, and being observed on a vertical wall. When the images coincide, the angle

of the prism is the altitude of the sun, and the meridional line may then be traced as in the method of the gnomon, which the author has already described in great detail [see Abstract No. 513 (1905)]. Examples of the observations made are given. S. G. S.

**667.** *Manometer Device for Air Thermometers.* **H. Edwards.** (Amer. Acad., Proc. 40. 13. pp. 541–545, Jan., 1905.)—The device is fitted immediately above the mercury surfaces, its object being to enable accurate readings of the mercury levels to be taken. AA′, seen in Fig. 1 in plan and elevation, are two glass plates containing, on their inner surfaces, scales on which the height of the mercury is measured. The plate of optical glass, E, has a horizontal line on each side next to the scale A, and another on its underside perpendicular to the sides mentioned. The distance from the side lines to the lower surface is determined beforehand by microscope, and the distance from the lower surface to the mercury is obtained by the use of the two glass prisms G and H. In each prism are seen two images of the lower line, one by means of direct rays, the other by rays reflected from the mercury, the shape and position of the prisms being such as to reverse the relative positions of the images (see Fig. 2). The vertical distance between the images is measured by cathetometer, and the distance between the glass and mercury surfaces then calculated. Among the advantages of the device are absence of distortion and freedom from levelling errors. G. E. A.

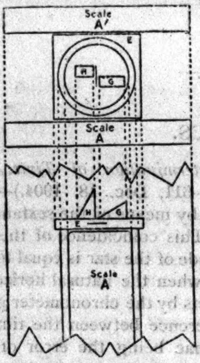

FIG. 1.

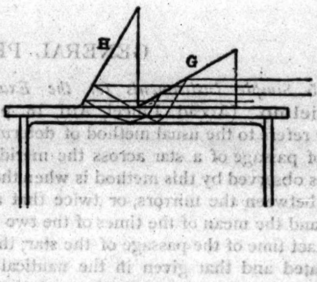

FIG. 2.

**668.** *Electric-Acoustic Sea-Sounding Apparatus.* (Scientific American, 92. p. 55, Jan. 28, 1905.)—The apparatus of H. Berggraf is briefly described, with which it is not necessary to touch bottom. The depth is ascertained by the time taken for a sound to travel to the bottom and return. The sound is emitted at intervals by a revolving contact operating an electric buzzer, and on its return is received by a "monotone" microphone arrangement. For exact work a registering apparatus is used. L. H. W.

**669.** *Lissajous' Figures by Tank Oscillation.* **T. Terada.** (Nature, 71. p. 296, Jan. 26, 1905. From Physical Laboratory, Tokyo, Dec. 19, 1904.)—The oscillation of a rectangular water basin is utilised for the illustration of the composition of two simple harmonic motions in two directions, perpendicular to each other. The bob of the pendulum is made of a disc of wood which is sunk into the middle part of a suitable rectangular basin filled with water to a proper depth. By tilting the basin the water is made to oscillate, its motion consisting of two simple harmonic motions in perpendicular directions. A mirror fixed to the pendulum rod enables the motion to be projected on the ceiling of the room. J. J. S.

670. *Alternating Stress Testing Machine at the National Physical Laboratory.* **T. E. Stanton.** (Engineering, 79. pp. 201–203, Feb. 17, 1905. Bull. Soc. d'Encouragement, 107. pp. 276–278, Feb., 1905.)—The principle adopted for this machine was that used by Reynolds and Smith [see Abstract No. 1802 (1903)], viz., the employment of a rotating crank to give reciprocating motion to a crosshead, the specimen under test forming the connection between this crosshead and another mass. Four cranks, however, are used in the present machine, in order that perfect balance and a practically constant speed of rotation may be obtained; at the same time, four specimens may thus simultaneously be tested under similar conditions of stress throughout their life. The tested portion of the specimens is ¼ in. diam. and ½ in. long. The crank radius is 2 in. for speeds up to 1,100 r.p.m., but for higher speeds a crank-shaft of smaller throw will be used. To give warning of the fracture of a specimen, bell-crank levers attached to the bed-plate are so placed that the slight displacement of the secondary crosshead due to compression of the buffers brings it in contact with one arm, the other dipping into a mercury cup and so completing a bell circuit. The machine is motor-driven through a modified Oldham coupling, and machine and motor are suspended by four ½-in. steel rods, so that any want of balance can be detected. The friction of the machine, which is the chief objection to the arrangement, was investigated; the resistance of the secondary crossheads was proportional to the speed, and would be very small when the stresses reach their maximum values in the neighbourhood of the dead points. An analytical investigation of the effect of the fluctuation of angular velocity of the shaft shows that the stress curves do not differ greatly from those which would be obtained if the angular velocity were constant, the chief difference being that the maximum value of the compression does not occur at the outer dead point, but at about 170°, and it is about 1 per cent. higher than that due to a uniform speed of rotation. F. R.

671. *Formation of Veins of Flow in Liquids.* **M. Smoluchowski.** (Acad. Sci. Cracovie, Bull. 8. pp. 371–384, Oct., 1904.)—The experiments were undertaken with the object of determining whether there is a discontinuity in the value of the velocity at the surface of zero pressure in the case of a liquid flowing through an orifice. According to Helmholtz, such discontinuity occurs in the case of a perfect fluid. The form of the lines of flow is determined by introducing a coloured fluid in the form of a fine jet, immediately before the orifice. The experiments indicate the presence of distinct veins, *i.e.*, diminution of the divergence of the lines of flow. The smaller the velocity, the less is the asymmetry of the lines of flow with respect to the plane containing the orifice. Also there is no critical velocity, the change in form of the lines with varying velocity being continuous. According to the theory of Helmholtz, the absolute pressure of the liquid plays an important part in the formation of a vein, and the author, therefore, altered the total pressure on the liquid, while keeping the differences of pressure everywhere constant. There is no change

in the stream-lines observed, and therefore Helmholtz's theory must be abandoned. According to the author, it is the ratio of the density of the liquid to its viscosity that determines the shape of the stream-lines, and he has used liquids of various densities and viscosities, and finds that at the corresponding velocities the stream-lines are identical. This bears out his theory. [See also Abstract No. 1318 (1903).] S. G. S.

672. *Brittleness of Certain Steels.* **A. Pérot and H. M. Lévy.** (Comptes Rendus, 139. pp. 1198–1200, Dec. 26, 1904.)—The authors have somewhat modified their impact-testing machine [see Abstracts Nos. 469 and 1025B (1904)], the velocity of the falling weight being now controlled upon the principle of Atwood's machine; and means have been adopted for registering the speed of movement of the sensitive plate upon which the load-strain diagram is recorded. The experiments have confirmed the conclusion as to the equality of breaking strength as measured by this machine or by static tension. No permanent set was found to occur in the particular steel tested unless the velocity of the blow was less than 6 m. per sec. The concave descending portion of the curves for brittle metals disappears when the striking velocity is greater than 6 m. per sec., for when the available energy of the blow is ample, the tup is not sufficiently retarded during the earlier stages to prevent the later part of rupture being of the same nature as that of brittle metals. F. R.

673. *Elasticity of Palladium.* **G. Ercolini.** (N. Cimento, 9. pp. 5–22, Jan., 1905.)—Palladium wires are subjected to elongational and torsional strain, both when in a natural state and when saturated with hydrogen, which is occluded by the palladium as it is liberated by electrolysis. The apparatus is described in detail, together with the method of conveying the electric current, which liberates the hydrogen, to the wire, and the method of making observations. The load is applied in an approximately sinusoidal manner, unilateral cycles being employed in the case of elongational strain, and both unilateral and bilateral cycles in the case of torsional strain. In all cases it is found that the curve representing the cycle on the stress-strain diagram encloses less area when the palladium is saturated with occluded hydrogen than when it is in the natural state; the hydrogen thus diminishes the hysteresis effect and makes the elastic properties more perfect. For a large cycle, however, the diminution in the hysteresis produced by the occluded hydrogen is less than for a small cycle. Experiments in which varying quantities of hydrogen are occluded have not yet been performed. S. G. S.

674. *Hardness of Steel at Various Temperatures.* **J. A. Brinell.** (Iron and Steel Mag. 9. pp. 16–19, Jan., 1905.)—The acid and basic steels experimented upon by the author each contained in per cent. C, 0·17; Si, 0·014; Mn, 0·85; and S, 0·015; the acid steel 0·028, and the basic 0·009 per cent. P. The specimens were annealed at 860° C., and were tested at 0°, 100°, 200°, &c., up to 1,200°, by pressing a 15 mm. ball into each under a force of 2,000 kg. and observing the diameter of the impression. From 0° to 500° the minimum hardness in each steel occurred at 200°. As Bach has found the ultimate strength of a mild steel to increase up to 300°, it might have been expected that the hardness would also increase, and this discrepancy may be due either to difference between the materials used by Bach and the author, or to variation with temperature of the assumed constant relation between ultimate

stress and hardness. The basic material was at all temperatures very slightly softer than the acid, except at 400° and 1,200°, where the figures coincide. F. R.

675. *Isochronism of Astronomical Clock Pendulums.* **C. Féry.** (Comptes Rendus, 140. pp. 106–107, Jan. 9, 1905.)—Observations made since 1901 with a Collier regulator appeared to show that the relation which exists between the amplitude of the balance and the rate of a clock does not conform to that of a free pendulum. Definite determinations were made by systematically varying the amplitude of vibration by changing the motive power. By means of a specially built thermostat it was known that the variation in rate produced by temperature changes was only of the order of 0·1 sec. It was found that for a variation of amplitude of 9 mm., from 2° 2′ to 2° 29′, the variation of rate was zero, and this indicated that for about 2° 18′ the balance had its minimum time of oscillation. The perturbation is ascribed to the defective isochronism of the escapement, which is generally so disposed to give the impulse after the passage past the vertical. These experiments may be useful in indicating the best amplitude to adopt for any particular clock movement. C. P. B.

676. *Rotating Viscous Liquids.* **J. Buchanan** and **H. W. Malcolm.** (Phil. Mag. 9. pp. 251–257, Feb., 1905.)—The liquids are placed in a hollow cylindrical drum which has its axis horizontal and is made to rotate by a falling weight attached by a string. The effect of the viscosity in giving an apparent increase of inertia to the system is thus studied. Curves of moving weight against increase of inertia are plotted for the liquids experimented on, viz., water, lamp oil, castor oil. J. W. P.

677. *Density Determinations with the Pipette. Adjustment of Standard Solutions from their Densities.* **F. W. Küster** and **S. Münch.** (Zeitschr. Anorg. Chem. 43. 3. pp. 373–383, Feb. 9, 1905.)—The density of an aqueous solution can be determined with the help of a sinker 10 c.cm. in volume, and by a single measurement, with an accuracy of at least ± 0·0001, no special precautions being taken. The same degree of accuracy can be reached by comparing the weights of water and of the solution delivered by an ordinary pipette of 100 c.cm. capacity at a definite temperature. If the neck of the pipette is quite narrow and certain precautions are observed, this accuracy may be increased to ± 0·00005. Using an automatically adjusting overflow-pipette, careful working gives an accuracy of ± 0·00001 for a single measurement. The determination of density with a pipette is sufficiently accurate as a basis for the preparation of normal solutions. T. H. P.

678. *Thickness of Transparent Films of Iron.* **L. Houllevigue.** (Comptes Rendus, 140. pp. 428–430, Feb. 13, 1905.)—In order to determine the thickness of the films of iron deposited on glass by kathodic projection [see Abstract No. 468 (1903)], the iron is dissolved off the glass by means of aqua regia and compared colorimetrically with a titrated solution of iron, the active colorimetric material being potassium sulphocyanide. In this way the amount of iron present, and therefore the thickness of the film, may be determined. Since this process destroys the film, it is desirable to devise some method of determining the thickness which does not injure the film. The author, therefore, measures the transparency of the film photometrically, and standardises

the observations by means of films whose transparency is determined before the iron is dissolved and treated as described above. It is found that the ratio of the thickness to the numerical value of the logarithm of the transparency is practically constant ; the logarithm being essentially negative, its numerical value increases as the transparency diminishes. S. G. S.

**679.** *Transmission of Gases through Water.* **W. E. Adeney.** (Roy. Dublin Soc., Trans. 8. 13. pp. 161–168, Feb. 20, 1905. Phil. Mag. 9. pp. 360–369, March, 1905.)—It has been found by Hüfner and others [see Abstract No. 502 (1905)] that the determination of the rate of diffusion of air through water and solutions is rendered difficult owing to the downward streaming effects, which Hüfner attributes to the sinking of the upper layers which have increased in density on dissolving the gas. The author has performed a number of experiments with the object of investigating this effect. The air is introduced at the top of a vertical tube containing either pure or sea-water, the introduction taking place in various ways : the air is sometimes brought into contact with the undisturbed surface of the water ; sometimes the water is mechanically stirred ; and sometimes the air is bubbled from various depths below the surface of the water. The extent to which diffusion has proceeded downwards into the column of water is determined by removing samples from various depths and finding the amount of nitrogen in the sample. It is found that the amount of dissolved gas in the lower layers is greater in the case of sea-water than with pure water. Further, on bubbling the air through the upper layers of sea-water, and then leading it to a similar column and doing the same again, it is found that the downward diffusion takes place much more rapidly in the first column than in the second, indicating that whatever it is that causes the downward currents noticed by Hüfner is removed by bubbling through sea-water. In the case of pure water, the difference in behaviour of the two columns is so small as to be hardly noticeable. The author suggests that the cause of the streaming is to be found in the minute dust particles or other centres of condensation which may be of an electrical nature, and which are absorbed at the same time as the gases, and that they bring about in some way a sufficient increase in the density to cause the downward streaming. Whatever their nature, they are much more readily absorbed by sea-water than by pure water. This is borne out by the fact that if the air be completely washed before being led to the column no streaming effects take place. S. G. S.

**680.** *Vibrations of Atoms Containing* 4, 5, 6, 7, *or* 8 *Corpuscles, and the Effect of a Magnetic Field on such Vibrations.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 13. pp. 39–48, Feb. 13, 1905.)—An atom containing 4 corpuscles in this paper is constructed as follows : Suppose a spherical space of radius $b$ uniformly charged with positive electricity, the total quantity being $4e$, and 4 negative corpuscles each of mass $-e$ placed at the angles of a regular tetrahedron whose centre is the centre of the spherical space. If $a$ be the distance from the centre of each of the 4 corpuscles, there will be equilibrium ; that is, the attraction of the positive mass on any one of the 4 corpuscles will be equal and opposite to the repulsion exerted on it by the other three, when $a^3/b^3 = 3\sqrt{3}/16\sqrt{2}$. Then denoting by $\xi_r$, $\eta_r$, $\zeta_r$ the displacements of the $r$th particle from its position of equilibrium, referred to a system of axes formed by joining the middle points of each of the three pairs of opposite sides of the tetrahedron, the vibrations are given by $m(d^2p/dt^2) = -kp$,

$m(d^2q/dt^2) = -kq$, $m(d^2r/dt^2) = -kr$, in which $p = \xi_1 + \xi_2 + \xi_3 + \xi_4$, and $q$ and $r$ have corresponding meanings, and $k = 4e^2/b^3$. Here $p$, $q$, $r$ are three principal co-ordinates. The system has twelve degrees of freedom, and the remaining nine principal co-ordinates are calculated. It is found that there are four different periods of vibration, the squares of which are in the proportions 1, 2, 3, 4. The magnetic field is then introduced, having components $\alpha$, $\beta$, $\gamma$. The consequence is that there will be terms in the expression $m(d^2\xi r/dt^2)$ equal to $e\beta(d\zeta_r/dt) - e\gamma(d\eta_r/dt)$, in addition to the terms independent of the magnetic field, so that, considering the first three principal co-ordinates, instead of $m(d^2p/dt^2) = -kp$, &c., we shall have $m(d^2p/dt^2) = -kp + e\beta(dr/dt) - e\gamma(dq/dt)$, &c. Solving this by the usual method, the writer finds that the period of this oscillation is the same as that given by Lorentz for a single particle. The effects on the other principal co-ordinates are then calculated. The method is then applied to atoms of 5 corpuscles, 4 of them at the angles of a tetrahedron as before, but with different value of $a$, and a fifth corpuscle at its centre. The atom of 6 corpuscles is formed by placing them at the angles of a regular octahedron. In the atom of 7 corpuscles the seventh is placed at the centre of the octahedron, and the atom of 8 corpuscles is formed by placing them at the angular points of a cube. S. H. B.

681. *Capillarity: Reply to a Remark by G. Bakker.* **H. Hulshof.** (Ann. d. Physik, 16. 1. pp. 188–192, Jan. 26, 1905.)—The question discussed in this paper is whether or not G. Bakker had in certain works of his [see Abstract No. 1320 (1899)] rightly interpreted certain works of the author, and whether Bakker holds and has expressed correct views concerning the molecular pressure near the bounding surface of a fluid. The author holds that this pressure has different values in different directions, and accuses Bakker of not having held this view consistently. Whatever be the merits of the personal controversy between these two eminent physicists, few readers will hesitate to accept the doctrine that, at points near enough to the bounding surface, the molecular pressure is, in fact, different in different directions. The difficulty is to accept van der Waals' doctrine that at points not near the bounding surface all the forces eventually cancel each other, although it has been received with surprising unanimity by physicists as *de fide.* S. H. B.

682. *Daily Temperature Variation in the Higher Atmosphere.* **L. Teisserenc de Bort.** (Comptes Rendus, 140. pp. 467–470, Feb. 13, 1905.)—The author gives particulars concerning the temperature distribution near Paris on the days March 3 to 19, 1903, and January 18 to 29, 1904. The isothermals are irregular and show closed curves in the lower 2 km.; almost regular and parallel, though by no means straight, in the stratum km. 3 to 10; and again most irregular in the inversion layers km. 10 to 13. In this latter isothermal zone the isothermals frequently rise vertically through heights of 3 or 4 km., and very peculiar temperature variations are found, greater even than those near the surface. Thus the most intense vertical movements take place in the zone above the stratum in which the normal temperature decrease ceases. [Compare Abstract No. 727 (1904).] H. B.

683. *Oscillations of Solar Activity and Climate.* **C. Easton.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 402–409, Dec. 7, 1904. Proc. 7. pp. 368–374, Dec. 21, 1904.)—The author considers that the parallelism between

solar activity and meteorology can only be visible in the general temperature curve of the tropical regions—not in that of the non-tropical zones and the earth as a whole—and that W. J. S. Lockyer—reference is made to Abstract No. 1865 (1901) only—selected an unsuitable meteorological element in taking Brückner's rainfall curve for comparison with the interval (M — *m*) of time between a sun-spot minimum and the following maximum. The author believes that the (M — *m*) curve (or rather Newcomb's deviations of the maxima and minima from their normal positions) showed a parallelity with the frequency of severe winters, cold winters coinciding with maximum sun-spot periods. Taking Köppen's climatic tables for the years 848–1900, he finds indications of a climatic oscillation period of 178 years (16 × 11·13, Newcomb's sun-spot period), further to be subdivided into cycles of 89, 44½, and 11 years. The oscillation of terrestrial temperature appears to be accelerated relatively to the eleven-year variation of solar activity in the colder part of the larger period, and retarded in the hotter part. H. B.

684. *High Barometer and Temperature Inversion, End of January.* **W. H. Dines.** (Nature, 71. p. 365, Feb. 16, 1905.)—The barometer rose in the night of January 26 in southern England, and remained at 31·0 in. during January 27 and 28. A kite rising to 3,600 ft. on January 28 marked the following temperatures at about 4 p.m.: Surface temperature 47° to 45° F., steadily falling to 40° F. at 3,000 ft.; at 3,300 ft. 52° F.; at 3,600 ft. 53° F. The air was very dry; the surface wind blew from the west, in the higher strata from north-west; there was no change in the direction in the inversion stratum. H. B.

685. *Influence of the Time Factor on the Correlation between Barometric Heights at Stations more than* 1,000 *Miles Apart.* **F. E. Cave-Browne-Cave.** (Roy. Soc., Proc. 74. pp. 403–413, Feb. 24, 1905.)—For the study of the relationship between the daily barometric heights on both sides of the Atlantic [see Abstract No. 284 (1903)] thea uthor has examined the records for twenty years from chains of stations along both Atlantic coasts, from the extreme north of Norway down to West Africa and the Cape, and from Nova Scotia down to the Falkland Islands; no observations were available from Brazil, however. The present paper deals particularly with the time factor in the correlations between Halifax, Nova Scotia, and Wilmington, North Carolina, and the period 1879–1898, divided into two decades and summer and winter seasons; the distance is 1,090 miles. St. Helena and Cape Town, 1,950 miles apart, are also referred to, the period being 1893–1898. The correlation is, for Halifax, and Wilmington, sensible for at least nine days, and attains its maximum value when the Halifax barometer is read 16 hours later than the Wilmington barometer in summer, and 23 hours later in winter. There is also considerable correlation in the daily rises and falls at the two stations, and it is possible to predict the barometer at one station from an earlier reading at the other. The mean error in these predications for forty dates is stated to be 0·15 in., but there are differences of ± 0·4 in the tables. H. B.

686. *Newton's Theory of Scintillation.* **K. Exner** and **W. Villiger.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 1019–1037, July, 1904.)—A series of measurements of star discs at different zenith distances are analysed and the results plotted, showing the variation in diam. with the zenith distance.

The observations used were made with the Munich Observatory refractor of 284 mm. (10½ in.) aperture. The chief factors affecting the diameters of the star discs were found to be (1) state of the atmosphere; (2) zenith distance of the star; (3) brightness of the star; (4) free opening of the objective. [See Abstract No. 58 (1904).] C. P. B.

687. *Comet* 1904*e* (*Borrelly*). **Borrelly.** (Comptes Rendus, 140. pp. 104-105, Jan. 9, 1905.)—This comet, discovered on December 28, 1904, at the Observatory of Marseilles, showed as a stellar nucleus surrounded by a feeble nebulosity having a diam. of 20″-30″, the whole greatly resembling a nebulous star of 10-11 magnitude. On December 31 the brightness was sensibly increased. **G. Fayet** and **E. Maubant** (Ibid. p. 105), **G. Fayet** (Ibid. pp. 259-261, Jan. 23, and pp. 296-297, Jan. 30, 1905.)—Preliminary computations of the elements of this comet indicated it to have the chief characteristics of comets of short period; successive reductions confirmed this view; the mean daily motion was found to be $\mu = 423''.915$, indicating a period of about 8 years (7 years in latest of these papers). Comparisons with the elements of former comets shows a close resemblance to the comet of 1783. C. P. B.

## REFERENCES.

688. *Model for Illustrating Wave Motion.* **K. Honda.** (Nature, 71. p. 295, Jan. 26, 1905.)—A description is given of a simple apparatus for illustrating the transversal as well as the longitudinal wave, which depends on the fact that the period of a pendulum varies with the length of the string. Motion is produced in a row of pendulums, and by means of a simple mechanism (illustrated in the note) a longitudinal wave can be transformed into a transversal one or *vice versâ.* J. J. S.

689. *Model Illustrating Hittorf's Migration Theory.* **F. H. Getman.** (Science, 21. pp. 153-155, Jan. 27, 1905.)—Eight black wooden balls are capable of sliding on a horizontal rod, an equal number of white balls are movable on a lower parallel rod. These balls represent the kathions and anions respectively. By moving these to the right or left the effect of different migration velocities can be readily illustrated and the use of several diagrams avoided. W. W. H. G.

690. *Young's Modulus Apparatus.* **C. H. Lees** and **R. E. Grime.** (Phil. Mag. 9. pp. 258-264, Feb., 1905.)—A compact apparatus for wires. The wire is stretched horizontally between two rigid supports, and is deflected by a weight attached at the middle point. From the droop, load, and dimensions the modulus is calculated. J. W. P.

691. *Water Pendulum.* **H. C. Richards.** (Phys. Rev. 20. p. 125, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904.)—A consideration of the proper distribution of mass and the effects of the relative weights of slider and bob. J. W. P.

692. *Method of Observing the Level of Large Surfaces of Mercury.* **A. Berget.** (Comptes Rendus, 140. pp. 79-80, Jan. 9, 1905.)—A horizontal collimator is used to illuminate the large column of mercury, so that the parallel beam is partly intercepted by the mercury. A small tube of mercury placed behind the large column presents a bright line of light where the parallel beam falls upon it. The point where this bright line ceases can be accurately determined by the kathetometer, and serves to measure the height of the large column. S. G. S.

693. *Bending Stresses in Tubular Tunnels laid in Wet Ground.* **C. Birault.** (Soc. Ing. Civils, France Mém., 57. pp. 433–467, Oct., 1904. Génie Civil, 46. pp. 121–123, Dec. 24, 1904.)—An analytical consideration of the stresses set up in tubular tunnels by the pressure of water percolating the surrounding ground. The paper refers chiefly to tunnels driven by means of a shield, and lined with cast-iron plates bolted together and grouted with cement. W. Ros.

694. *Lateral Vibrations of Bars.* **C. Chree.** (Phil. Mag. 9. pp. 134–136, Jan., 1905.)—A criticism of the considerations of Abstract No. 21 (1905) on the same subject. J. W. P.

695. *The Frémont Method for Brittleness of Steel.* **T. Y. Olsen.** (Eng. Club Phil., Proc. 22. pp. 57–71; Discussion, pp. 71–73, Jan., 1905.)—An account of impact-testing as studied by Frémont is given, with a description of the present commercial form of his drop machine for notched bar tests. Some of the typical figures which have been obtained are added, with, for comparison, static tests of the same materials. [See also Abstract No. 290B (1905)]. F. R.

696. *Lateral Vibrations of Bars.* **H. C. Richards.** (Phys. Rev. 20. pp. 125–126, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904.)—The nodal points are calculated by Rayleigh's method, and comparison is made between the positions of corresponding nodes with different end conditions. J. W. P.

697. *Melting-point of Floating Ice.* **C. M. van Deventer.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 490–493, Jan. 5, 1905. Proc. 7. pp. 459–462, Jan. 25, 1905.)—The author draws attention to the fact that when ice is floating in water the level of the liquid does not rise when the ice melts, owing to the fact that the volume of the water produced is equal to that of the submerged ice. The same holds for the melting of any solid in its liquid. The author calls this the law of permanent levels. A. F.

698. *Flow of Water in Rotating Canals.* **H. Lorenz.** (Phys. Zeitschr. 6. pp. 82–88, Feb. 1, 1905.)—A contribution to the theory of turbines, in which the conception of the mean stream-line is not used, but the fundamental equations of hydrodynamics in cylindrical co-ordinates are employed. It is too mathematical for an abstract. R. E. B.

699. *Diffusion of Hydrogen through Palladium.* **O. W. Richardson.** (Cambridge Phil. Soc., Proc. 13. pp. 27–32, Feb. 18, 1905.)—The author has shown that the diffusion of hydrogen through platinum may be explained on the hypothesis that the gas inside the metal is in a state of dissociative equilibrium, and that only the dissociated atoms diffuse freely [see Abstract No. 2460 (1904)]. Schmidt's experiments on palladium tend to throw doubt on the theory [see Abstract No. 1589 (1904)], but the author shows they do not disprove it. Fresh experiments are necessary. R. S. W.

700. *Deviation during Free Fall.* **de Sparre.** (Comptes Rendus, 140. pp. 363–365, Feb. 6, 1905.) **M. Fouché.** (Ibid. pp. 427–428, Feb. 13, 1905.)—De Sparre maintains his results [see Abstract No. 508 (1905)] against Fouché's criticism [Abstract No. 509 (1905)], in which terms are omitted that should be taken into account. Fouché's results differ from de Sparre's by reason of difference in the fundamental assumptions. R. E. B.

701. *Recomparison of the U.S. Prototype Metre.* **L. A. Fischer.** (Bureau of Standards, Bull. 1. 1. pp. 5–19, Nov. 1, 1904.)

**702.** *Gravitation Constant.* **A. Föppl.** (Phys. Zeitschr. 6. pp. 113–114, Feb. 15, 1905. Mech. techn. Laborat. der k. techn. Hochschule, München, Jan., 1905.)—An account of the experiment on the value of the constant by means of the action of a rotating flywheel on a torsion balance in its neighbourhood. The results are negative. J. W. P.

**703.** *Long-range Weather Forecasts.* **E. B. Garriott.** (U.S. Department of Agriculture, Weather Bureau Bulletin, No. 35. pp. 7–10 and 33–68, 1904.) **C. M. Woodward.** (Ibid. pp. 11–31.)—Woodward destructively criticises Tice's theory dealing with the planetary equinoxes.

**704.** *Results Obtained with a Sarasin Limnograph at Lake Garda.* **E. Teglio.** (Accad. Lincei, Atti, 14. pp. 90–92, Jan. 22, 1905.)—A preliminary account. D. H. J.

**705.** *Pyrheliometric Measurements in* 1900 *and* 1901 *at Modena.* **C. Chistoni.** (Accad. Lincei, Atti, 14. pp. 147–153, Feb. 5, 1905.)—An account of further measurement with a Violle actinometer [see Abstract No. 271 (1904)].

**706.** *Seismic Records at Göttingen, July to December*, 1903. **G. v. d. Borne.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 5. pp. 440–464, Dec., 1904.)—Tables of the records obtained with a Wiechert astatic pendulum of 1,200 kg. Calculation of the distance of the epicentre after W. Laska seemed in many instances to give correct results. H. B.

**707.** *Graphical Determination of Cometary Orbits.* **L. Weinek.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 987–1006, July, 1904.)—The author develops a graphical determination of Olbers' method for calculating comet orbits and computing ephemerides. C. P. B.

**708.** *Spectra of γ Cygni, α Canis Minoris, and ε Leonis.* **E. Haschek** and **K. Kostersitz.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 925–972, July, 1904. From the II. Phys. Inst. der k.k. Univ., Wien.)—Tables of the lines measured in the star spectra are given, with the most probable metallic origins determined from both arc and spark spectra of the terrestrial elements. The lines given for γ Cygni extend over the region λ4250·26–λ4534·38, of α Canis Majoris from λ4126·15–λ4549·59, and of ε Leonis from λ4215·76–4574·04. Full details of the method of analysis and subsequent reduction of the spectra are given. C. P. B.

**709.** *Co-operation in Solar Research.* **G. E. Hale.** (Astrophys. Journ. 20. pp. 306–312, Dec., 1904. Introductory remarks of Chairman of Committee on Solar Research of National Academy of Sciences.)—The author thinks it should be possible to find a suitable compromise between a central bureau controlling all observations leaving little or no initiative to the skilled observer, and an arrangement whereby the work required should be merely decided upon and distributed, its accomplishment being left entirely to the discretion of the observer. The important work of observing the spectra of sunspots is instanced as an example; where the whole is so extensive as to be beyond the power of a single institution, but could with advantage be completely followed out if each of the bodies having sufficient instrumental power be allotted a definite section of the spectrum for examination. C. P. B.

**710.** *Comet Giacobini* (1904). **Giacobini.** (Comptes Rendus, 139. pp. 1192–1193, Dec. 26, 1904, and 140. pp. 924–925, April 3, 1905.)—The author gives the elements, positions of comparison stars, and ephemeris of the comet observed by him on December 17, 1904, with the equatorial coudé of the Nice Observatory. **G. Fayet** and **E. Maubant.** (Ibid. p. 1194, Dec. 26.) **E. Maubant.** (Ibid. 140. p. 926, April 3.) C. P. B.

## LIGHT.

711. *Spectrograph with Strong Illumination.* **H. Lehmann.** (Zeitschr. Instrumentenk. 24. p. 358, Dec., 1904. Physikal. Inst. der techn. Hochschule, München, Oct., 1904.)—A Steinheil instrument containing a direct-vision, five-prism train in which incidence and emergence are normal for the mean ray. This does away with much loss of light. The total dispersion is 12°, the distance between the A and H lines being 50 mm. The camera is a "unofocal" with an anastigmatic photographic objective corrected for spherical and chromatic errors. G. E. A.

712. *Luminescope for Comparing Substances under the Influence of Radium Rays.* **C. S. Webster.** (Soc. Chem. Ind., Journ. 23. pp. 1185–1186, Dec. 31, 1904.)—A modification of the spinthariscope is described which enables different substances to be compared as regards "glow" as well as scintillating power. The chief feature is the use of a disc carrying four screens, one of which can be removed at will, and any other screen of finely divided substance, or mounted fragments of minerals, substituted. The disc is contained in a box, on which the eyepiece tube is mounted, and is rotated by means of a handle; the screens may thus be rapidly brought under the eyepiece and compared. L. H. W.

713. *Hornstein's Tacheometer-Theodolite.* (Engineering, 79. pp. 177, 179, Feb. 10, 1905.)—A special feature of this instrument lies in the fact that the distances of inaccessible objects and their heights above the level may be measured by its means. Its mode of working consists in sighting the object whose distance is required, tilting the telescope down through a fixed angle, and then raising it parallel to itself in a vertical direction until the object is again sighted at the cross-wires. The angle of tilt is so made that the distance of the object is 1,000 times the vertical lift of the telescope. The mechanical construction of the instrument may be made out from the drawings and photograph given. Tests of the instrument, which is made in Altona, show that its readings for a distance of 300 m. measured by steel tape varied between 299·3 and 301·0 m. G. E. A.

714. *Simple Burner for a Thallium Flame.* **H. Kreusler.** (Deutsch. Phys. Gesell., Verh. 7. 3. pp. 59–60, Feb. 15, 1905.)—An arrangement of two horizontal glass tubes, one of which is bent up at the end to form a burner, and has a bulb near the middle containing thallium chloride. The other tube has a nozzle through which coal gas is passed into the first tube; air is drawn in with the gas, and the mixture passes over the thallium salt which is heated by a small flame. An intensely green flame results, which lasts well and gives a pure spectrum. G. E. A.

715. *Radio-photometer.* **K. Siegl.** (Zeitschr. Instrumentenk., Beib. 4. pp. 33–34, Feb. 15, 1905.)—The author has devised an instrument by which quantitative measurements of the radiation intensity of radio-active substances can be made by the fluoroscopic method. This consists in bringing into the same field of view, by means of a double total-reflection prism, a small

barium platinocyanide screen in the focus of a lens, behind which the radio-active substance is placed, and a small yellowish-green transparent screen in the focus of another lens, and behind which a lamp with constant flame (benzine) is placed. The transparent screen and lens system is moveable, and is adjusted by a rackwork and pinion until the two halves of the field appear equally bright, a standardised radio-active substance being first used and then the test substance; the intensity is obtainable as in photometer calculations. A sectional diagram is given of such an instrument, and of a simpler form, in which the fluorescent screen is viewed direct and the transparent screen by means of a prism as before. The screen is, however, fixed, and a glow lamp takes the place of the benzine lamp; the lamp is the only moveable part, and the position of this is read off on a scale. This form has advantages over the first. L. H. W.

716. *Tangential Stress of Light Obliquely Incident on Absorbing Surface.* **J. H. Poynting.** (Phil. Mag. 9. pp. 169–171, Jan., 1905. Paper read before the British Assoc. at Cambridge, Aug., 1904.)—The normal pressure of light predicted by Maxwell's theory has been fully confirmed by Lebedew, and also by Nichols and Hull. These experiments show that the pressure is equal to the energy density of the beam. The beam may thus be regarded as a stream of momentum in the direction of propagation, the amount of momentum passing per second per unit cross-section of the beam being equal to the density E of energy in it per unit volume. The present author shows that the normal and tangential stresses are respectively $E\cos^2\theta$ and $E\sin\theta\cos\theta$ for a beam incident at angle $\theta$ and entirely absorbed. Hence the tangential stress is a maximum for $\theta = 45°$. If $\mu$ of the beam is reflected, these expressions become $(1+\mu)E\cos^2\theta$ and $(1-\mu)E\sin\theta\cos\theta$ respectively. Thus for no absorption the tangential stress disappears. To detect this tangential stress the following apparatus was used: Two glass discs, each 2·75 sq. cm. area, were fixed perpendicularly on the ends of a light glass rod 5 cm. long hung by a cradle and a quartz fibre. One of the discs was lampblacked, the other silvered. The deflections were optically measured, one scale division corresponding to a tangential force of about one two-millionth of a dyne. The containing vessel was exhausted to 1 cm. of mercury, when the beam from a Nernst lamp turned the "needle" through 16·5 scale divisions. This corresponded to $E = 5{\cdot}8 \times 10^{-6}$. The value of E as measured by a thermo-junction of constantan was $6{\cdot}5 \times 10^{-6}$, a very good agreement for the present apparatus. E. H. B.

717. *Trains of Dispersive Waves.* **J. Larmor.** (Cambridge Phil. Soc., Proc. 13. pp. 21–24, Feb. 13, 1905. First section communicated to the British Assoc. at Cambridge, Aug., 1904.)—If we are content with a naïve theory of an independent vibrator for each line of the spectrum, or even with a conception of a molecule as a connected dynamical system vibrating about a position of *rest*, it is readily inferred that the index of refraction always trends upward with increasing frequency, so as to be abnormally great on the lower side of an absorption band, and abnormally small on the upper side of it, as was originally remarked by Kundt to be actually the case in anomalously dispersive media. But when the molecule is considered (as it must be, notwithstanding analytical difficulties) to be a dynamical system vibrating about a permanent state of steady cyclic motion, the gyrostatic terms in the equation of its vibrations render a theoretical discussion of Kundt's law difficult. Light has, however, recently been thrown on the subject by

Schuster and Lamb. When in optics a wave-length $\lambda_0$ is spoken of, it must be taken to mean wave-lengths within a small interval $\delta\lambda$ around $\lambda_0$, *i.e.*, a train of waves of uncertain length from point to point within this interval $\delta\lambda$, which is itself a measure of the defect of purity of the beam. There is no such thing as an absolutely homogeneous train of wave-length exactly $\lambda_0$. The subject of wave velocity and group velocity on the lines of Stokes and Rayleigh is now entered upon. The curve of dispersion is usually constructed with the frequency $\nu = \tau^{-1}$ as abscissæ, and the index of refraction $\mu$ as ordinate. Then if $c$ is the velocity of light in a vacuum, $\lambda = (c/\mu)/\nu$. Thus the group velocity $U = d\nu/d(1/\lambda)$ is $c d\nu/d(\mu\nu)$. Hence—

$$c/U = d(\mu\nu)/d\nu = \mu + \nu(d\mu/d\nu).$$

This must be positive; thus $d\mu/d\nu$ can indeed be negative, but the greatest allowable negative value at any point is $-\mu/\nu$. So far, then, as this present condition goes, the dispersion curve *may* trend downwards, but to a limited extent, outside a band of absorption, whereas upward trend is unrestricted. The character of the curve of dispersion would be in the main that remarked by Kundt. The principle involved in propagation by groups is then somewhat generalised. The equation $y = Af(nx - pt)$ represents a disturbance of profile, $y = Af(nx)$ propagated with speed $p/n$; when the form is a periodic undulating one the equation represents a progressive wave-train of definite wave-length. Now let there be an aggregate of related forms all differing slightly from a central type $y \propto f(n_0x - p_0t)$ but otherwise undetermined. It is then shown that this aggregate may be represented by—

$$y = \phi(x - U_0t)\,F(n_0x - p_0t),$$

where $U_0 = \delta p/\delta n =$ a constant. Thus, to an observer travelling with speed $U_0$, so that $x - U_0t$ remains constant, the aggregate disturbance *in his neighbourhood* has the features of a simple disturbance of type $y = CF(n_0x - p_0t)$, viz., of form $y = CF(n_0x)$ travelling with speed $p_0/n_0$. This resultant form $y = CF(n_0x)$ is not necessarily the same as the original standard form $y = Af(n_0x)$, belonging to the components which make it up. But if the components are sines or cosines, so is their resultant. Thus the local features of a train of waves of nearly identical types travel with a definite speed, different from that of the individual waves, and therefore travel through the waves, but the travelling group is of the same type as its components *only* when these latter are of sine or cosine form. E. H. B.

718. *Examination of a Microscope Objective.* **K. Strehl.** (Zeitschr. Instrumentenk. 25. pp. 3–10, Jan., 1905.)—The investigation is a theoretical, not a practical one, and is based on the laws of diffraction. The author remarks that in certain cases he has found the theory of diffraction to give results contradictory to those following from geometrical optics. Contrary to the usually accepted view, he believes that spherical aberration as an accompaniment of chromatic aberration may have a beneficial effect. The objective in question is a $\frac{1}{6}$-in. of focal length 3·9 mm. and numerical aperture 0·65, made of Jena glass from calculations by Kerber. The examination is undertaken for five different wave-lengths, C, D, E, F, and $m = 550\,\mu$ (the place of maximum brightness), and for six different zones of the objective, the figures being shown in a series of tables, while a diagram illustrates the final results. In any zone let $h$ denote the vertical diameter at exit

(Austrittshöhe), $p'$ the width of a section as affected by aberration, we hence obtain $\Delta$ the longitudinal aberration. Taking $h$ as abscissa and $-\Delta h/p'^2$ as ordinate, and summing the area of the resulting figure in strips as described in a previous article [see Abstract No. 754 (1905)], the deviation $\gamma$ of the actual wave-surface from the sphere touching it centrally is obtained. The actual wave-surface not being spherical, suppose it replaced by an ideal spherical surface meeting (not touching) it at centre and border, and let $\gamma_0$ be the deviation of this ideal wave-surface from the central tangent sphere above mentioned. Then the difference $\gamma - \gamma_0$, which is the deviation of the actual wave-surface from the ideal sphere replacing it, affords a criterion of the excellence of the image as regards spherical aberration. To judge of chromatic aberration, the author calculates the deviation $\gamma' - \mu_0$ of the actual wave-surface for a given colour from the ideal spherical wave-surface for the brightest colour. The difference $\gamma' - \mu_0$, which is expressed in $\mu\mu$, is then transformed to degrees by taking $360° = 2\pi = \lambda$. Calling the result $\theta$, and letting $\tilde{\omega}$ be the area of the corresponding zone, the expression $\frac{[\Sigma(\tilde{\omega}\cos\theta)]^2 + [\Sigma(\tilde{\omega}\sin\theta)]^2}{\Sigma(\tilde{\omega})} = \phi$ is calculated for each colour, $\Sigma$ here denoting summation for the six zones. Then the brightness for definition (Definitionshelligkeit) as regards combined spherical and chromatic aberration is measured by the quantity $\Sigma(\phi\iota')/\Sigma(\iota')$, where $\iota' = \iota/\lambda^2$ is the reduced brightness (reduzierte Helligkeit) for an individual colour, $\Sigma$ in this case denoting summation for the five colours. In the discussion of the results the effect of various modes of illumination are considered. The author, in a concluding paragraph, explains some phenomena seen in examining diatoms under the microscope, which are due to superposition of red and green chromatic images. A. E.

719. *Increase of Brightness with Temperature.* **R. Lucas.** (Phys. Zeitschr. 6. pp. 19–20, Jan. 1, 1905.)—Rasch has expressed the relation between the brightness, $\phi$, of a glowing body and its absolute temperature, T, by the equation $\log_e \phi = C - K/T$, where C and K are constants [see Abstract No. 2526 (1904).] By taking logarithms of Wien's equation for the law of increase of brightness of monochromatic light a similar equation is obtained in which the constant K has the value $C_2/\lambda$. Wien's constant $C_2$ has a value about 14,500, whilst Rasch has calculated from Lummer and Kurlbaum's numbers [see Abstract No. 2407 (1900)] that K is 26,750. The mean wave-length can then be calculated from $26{,}750 = 14{,}500/\lambda$, and the result is $\lambda = 0{\cdot}542$, a value lying very close to $\lambda = 0{\cdot}535$, the wave-length for which the retina has maximum sensibility. G. E. A.

720. *Influence of Electrical Vibrations on the Breadth of the Finest Spectral Lines.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 6. 23. pp. 344–348, Dec. 15, 1904.)—Using an arrangement of Lilienfeld's, the secondary of an induction coil is connected to a circuit containing a capacity, an inductance, and a spark-gap. By placing the vacuum tube as a shunt to the inductance, but slight damping is caused to the oscillations in the main circuit. The capillary parts of the vacuum tubes could be viewed, end on, from end to end, the spectra investigated being those of hydrogen, helium, sodium, argon, and mercury, and the spectroscope employed having a resolving power of 228,000 [see Abstract No. 1362 (1903)]. Whilst the lines are more or less sharp in the interference-spectroscope with a glow discharge through the tube, they all broaden when caused by an oscillatory discharge,

the effect being least in mercury and greatest in hydrogen. The broadening is explained by means of Doppler's principle, and, taking the broadening of the hydrogen lines H$\alpha$ and H$\beta$, which amounted to more than the dispersion, $\Delta \lambda = \lambda : 12{,}000$, of the spectroscope, a lower limit of 17,000° abs. is found for the temperature of the luminous gas. The broadening of the line is inversely proportional to the square root of the molecular weight of the gas. G. E. A.

721. *Orthochromatic Plates and Sensitisers.* **A. J. Newton** and **A. J. Bull.** (Photographic Journ. 45. pp. 15–20, Jan.–Feb., 1905.)—A record of spectrum photography, the spectrum being that of an acetylene burner produced by a prism-grating. A graded series of exposures to the spectrum was made on each plate, in the ratios of 1, 3, 9, and 27. The results are given in tables and illustrations, and include tests of green-sensitive plates, panchromatic plates, collodion emulsion containing various dyes, and bathed plates. The latter give much better results than plates in which the dye is incorporated in the emulsion. [See also Abstract No. 335 (1905).] G. E. A.

722. *Dark-room Light Filters.* **A. J. Newton** and **A. J. Bull.** (Photographic Journ. 45. pp. 20–21; Discussion, pp. 21–22, Jan.–Feb., 1905.) —To make a light filter for the illumination of the dark-room during the development of colour-sensitive plates, glass plates are coated with gelatine solutions of certain dyes, which absorb the effective rays. The proportions of dyes are given for making yellow, red, and blue-green safe lights. In making the lights a piece of *papier mineral*, or tissue paper, is placed between the gelatine surface and a covering glass. In the *discussion* [which refers also to the preceding Abstract], **C. E. K. Mees** said that, though the tests were, no doubt, valuable for spectrum photography, the colour screen method was the better for commercial work. **A. J. Bull** thought this might be so, as regards the development factor, but the method had been chosen in view of three-colour work, in which three negatives had to be made. G. E. A.

723. *Lippmann Spectra of Second and Third Order in Natural Colours.* **H. Lehmann.** (Phys. Zeitschr. 6. pp. 17–19, Jan. 1, 1905. Physik. Inst. d. techn. Hochschule, München.)—Ordinary sensitised Lippmann plates are not sensitive to waves longer than 800 $\mu\mu$, but by breathing on the gelatine the swelling of the latter causes an increase of the distance between the Zenker layers, which renders the film suitable for photographing the infrared by the production of optical overtones. The procedure followed is to breathe on the plate while it is in the rays of a spectrum in the neighbourhood of the extreme red. The photograph is afterwards placed obliquely in a saucer filled with benzol [see Abstract No. 49 (1900)], when the higher order spectra may be seen. By cementing a glass wedge over the film a specimen was obtained which lasted for some months. G. E. A.

724. *Double Refraction near Components in the Zeeman Effect.* **P. Zeeman** and **J. Geest.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 516–520, Jan. 5, 1905. Proc. 7. pp. 435–438, Jan. 25, 1905.)—The magneto-optic theory of Voigt [see Abstract No. 1140 (1899)] established a simple connection between the magnetic splitting up of the spectral lines of dispersion, and accounts extremely well for all the phenomena observed

in the region of the absorption lines. If light traverses parallel to the magnetic lines of force, very attenuated sodium vapour, the plane of polarisation is rotated in the positive direction for all periods lying outside the components of the doublet, but in the negative direction, and very strongly, for periods intermediate between those of the components [see Abstract No. 1842 (1902)]. If light traverses the vapour normally to the field, there is double refraction, as predicted by Voigt from theory. When placed in a magnetic field, all isotropic bodies should show double refraction, but to a measurable degree only in the neighbourhood of the absorption lines. Voigt and Wiechert experimentally verified this result, using a small grating and a flame with relatively much sodium vapour. Zeeman has extended these results [see Abstract No. 80 (1904)] by using sodium vapour so dilute that in a strong field there were seen four absorption lines corresponding to the components of the quartet into which the line D is split by the magnetic field. These experiments have now been carried still further by J. Geest, whose results are here compared with theory, the agreement being shown on a plate which gives theoretical curves and the observed spectra for a triplet, a quartet, and a sextet. E. H. B.

725. *Ultra-violet Spectrum of Gadolinium.* **W. Crookes.** (Roy. Soc., Proc. 74. pp. 420–422, Feb. 24, 1905.)—The ultra-violet spectrum of some gadolinium purified by Urbain by fractional crystallisation of the double nitrates of bismuth and magnesium with the rare earths, has been photographed with the iron spark spectrum in juxtaposition as a standard, the apparatus being the same as that employed for the spectrum of radium [see Abstract No. 2602 (1904)]. The impurities present are yttrium, europium, samarium, ytterbium, scandium, bismuth, magnesium, and calcium. The phosphorescent spectrum of this gadolinium also shows the victorium bands previously found by the author in other specimens, while in a further quantity of gadolinium considered by Urbain to be quite pure, these bands are even more pronounced. It is concluded, however, that victorium is not gadolinium, but only present in it as an impurity. W. H. Sl.

726. *Phosphorescent Alkaline Earths.* **P. Lenard and V. Klatt.** (Ann. d. Physik, 15. 2. pp. 225–282, Oct.; 15. 3. pp. 425–484, Nov.; and 15. 4. pp. 633–672, Dec. 6, 1904. Extract of paper presented to the Hungarian Academy of Sciences.)—The authors showed some years ago that certain sulphides of the alkaline earths which gave particularly striking phosphorescence effects owed this property to the simultaneous presence of three components, viz., the sulphide itself, traces of a foreign metal, a fusible flux. The influence of each of these components is here examined, the research extending to some 800 preparations. The results are given in the form of tables. Some of the general conclusions are as follows: The flux causes an alteration in the colour of the emitted light, not through a change in the number of emission bands, but through an alteration in the relative intensity of the bands already present and in their relative duration. Fluxes which are chemically similar act in the same way as each other. The duration and intensity of each band are independent of other bands. Each foreign metal present gives characteristic bands. R. S. W.

727. *Effect of Metals on a Photographic Plate.* **G. W. A. Kahlbaum and M. Steffens.** (Phys. Zeitschr. 6. pp. 53–60, Jan. 15, 1905. Paper read

before the Naturforsch. Gesell. in Basel, Dec. 7, 1904.)—Strips of various metals are placed between two photographic plates without being in actual contact with them. After being left in this position for several days, the plates are developed. The lower is found to be affected much more than the upper one, as would be the case if a heavy emanation were given out by the metal. The photographic effect can be intensified by means of a centrifugal machine, which assists the emanation to travel from metal to plate. R. S. W.

728. *New Phenomena of Fluorescence.* **H. W. Morse.** (Phys. Rev. 20. p. 122, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904.)—The fluorescent spectrum of fluorspar, procured by the spark between certain metals, exhibits, in certain varieties of the mineral, numerous bands and sharp lines. About 125 lines have been measured. The spectrum varies from metal to metal, and the light which excites the lines lies between λ3000 and λ2000. Removal of the air lines by employing an inductance in the secondary circuit causes the disappearance of a large number of the fluorescent lines. S. G. S.

729. *Luminescence of Sidot Blende.* **E. L. Nichols** and **E. Merritt.** (Phys. Rev. 20. pp. 120–122, Feb., 1905. Abstract of paper read before the Amer. Physical Soc. Dec. 30, 1904.)—The apparatus employed has already been described [see Abstracts Nos. 2554 and 2555 (1904)]. The blende is employed in the form of a screen. The luminescence consists of two well-marked bands. ($\lambda = 0{\cdot}507\mu$ and $\lambda = 0{\cdot}432\mu$.) The violet band is excited by the ultra-violet portion of the spectrum of the iron or zinc arc, and the green band, most readily by the violet bands of the carbon arc. Both bands are excited by Röntgen rays, but the violet band the more intensely. The rate of decadence of the phosphorescence spectrum, in the case of the green band, is determined. For the first few seconds the decadence curves are almost exactly hyperbolic, but later, when the decay is much more slow, they are nearly of the exponential type. S. G. S.

730. *Properties of Radium Salts.* **O. Rebuffat.** (Accad. Sci. Fis. Mat. Napoli, Rendiconti, 10. pp. 133–134, 1904.)—On vigorously rubbing a glass rod with a woollen cloth and approaching the finger to the rod, sparks are given off visible in the dark. If the experiment is made in the neighbourhood of a radium salt, the rod appears luminous all along the line of contact of the rod and cloth during the time the rubbing is taking place; if the finger is now rubbed along a rod, a luminous streak appears along the latter. The same phenomenon occurs when the rod is replaced by an evacuated glass tube. If a sealed tube containing a radium salt and furnished with a tap is connected with an exhausted tube and the tap then opened, the previously exhausted tube will become luminous when rubbed with a woollen cloth, even after the lapse of several days. T. H. P.

731. *Comparison of Röntgen Rays with Radiations from Radio-tellurium.* **E. Villari.** (Accad. Sci. Fis. Mat. Napoli, Rendiconti, 10. pp. 159–160, 1904.) —The radiations from a copper rod covered with radio-tellurium have a less penetrating power than Röntgen rays. They are stopped by glass or aluminium, 1 mm. or less in thickness, and are incapable of passing through a sheet of ordinary paper. They penetrate slightly a linen handkerchief, and to a greater extent a very thin bladder or sheet of parchment. The air

blown from a bellows over a glass tube rubbed on the radio-tellurium rapidly acquires the power of discharging an electroscope, and loses it slowly. When the rod itself is placed near the knob of the electroscope, the latter is rapidly discharged, but the discharge is retarded or accelerated by blowing the active air away from or towards the electroscope. Air rendered active by Röntgen rays loses its discharging power to only a small extent when passed through a slightly electrified tube, but if the electrification of the tube is strong, the air ionised by the Röntgen rays has to be passed for about 2 hours in order to discharge the tube. On the other hand, air ionised by the radio-tellurium reduces a strongly electrified glass tube to a non-electrified condition in a few minutes. If the discharging capacity of carbon dioxide submitted to the action of the radio-tellurium radiations is taken as 1, that for air is 3–5, that for illuminating gas 7–8, and that for hydrogen 20.
T. H. P.

**732.** *Origin of Temporary Radio-activity.* **E. Sarasin, T. Tommasina, and F. J. Micheli.** (Comptes Rendus, 139. pp. 917–920, Nov. 28, 1904.)—The authors describe some experiments on the rate of decay of the radio-activity induced by the action of atmospheric air upon electrified wires [see Abstract No. 1093 (1902)]. An Elster-Geitel dispersion apparatus was used, and the wire under observation, wound on a metal frame, was placed inside a small blackened metal cylindrical receptacle in contact with the electroscope terminal. As a result it was found: (1) That the curves for the decay were exponential in form, and after 2 or 3 hours, according to the activity acquired, became asymptotic, as in the case of the activity induced by the emanations of radio-active bodies. The decay to half value takes place in 1 hour, falling again to half by the end of the second and of the third hour, but after that only in 5 or 6 hours, 20 hours, &c., a feeble activity being still traceable after 3 days. (2) The rate of decay is practically the same with all metals which have been made active, whether in atmospheric air or in air ionised by Röntgen rays, but in the former case the activity reaches the same value whether the window is open or shut, while the Röntgen rays have no action if the window is open during the activation. The induced radio-activity is, in the case of Röntgen rays, due to the ionisation of the medium, and not to the direct radiation, so that the presence of traces of radio-active substances is not justifiable to explain the Elster-Geitel effect. Changing the sign of the charge given to the electroscope was found to give two curves, of which the positive was always the higher—from which the conclusion is drawn that this temporary radio-activity contains two typical emissions of opposite sign $\alpha$ and $\beta$. The rest of the paper is devoted to an explanation of the reason for the difference in the curves. These considerations lead the authors to think that the phenomena of ionisation and temporary radio-activity are in a sense reversible.
L. H. W.

**733.** *Inactive Thorium.* **C. Baskerville and F. Zerban.** (Amer. Chem. Soc., Journ. 26. pp. 1642–1644, Dec., 1904. Chem. News, 91. pp. 74–75, Feb. 17, 1905.)—It had been found (with one exception) that thorium is active only when, but always when, the minerals yielding it contain other radio-active substances. A new rock from South America has been discovered which yields perfectly and initially inactive thorium, neither the thorium nor barium contained showing any radio-activity. No $\alpha$-radiations are given off, and the barium within 140 and thorium within 290 hours did not affect a photographic plate through black paper. **F. Zerban.** (Ber. Deut. Chem. Gesell. 38. p. 557, 1905. Chem. News, 91. p. 121, March 17, 1905.) Further considerations. [See also Abstract No. 100 (1904).] L. H. W.

734. *Heating Effect of the γ-Rays from Radium.* **E. Rutherford** and **H. T. Barnes.** (Nature, 71. pp. 151–152, Dec. 15, 1904.)—Experiments are described which contradict the conclusion of Paschen that the γ-rays from radium supply a large proportion of the total heat emission. When radium bromide was surrounded (1) by lead and (2) by aluminium cylinders of the same dimensions, and the heating effect measured in each case by a differential air calorimeter, the difference was found to be slight, though the lead enveloper absorbed more than half the γ-rays, and the heating in that case would have been, according to Paschen, about 50 per cent. greater than when aluminium was used. J. J. S.

735. *Action of Radium Rays on Caoutchouc.* **R. Ditmar.** (Chem. Centralblatt, pp. 1652–1653, 1904. From Gummi-Zeitung, 19. pp. 3–4, 1904.) —The author has investigated, by Mme. Curie's method, the penetrating power of radium rays on caoutchouc. A concentrated preparation of radium bromide (de Heen's) was found not strong enough to induce radio-activity in the caoutchouc itself. From these experiments and those of Mme. Curie the conclusions are drawn that: (1) The radium rays (γ-rays) penetrate both crude and vulcanised rubber, though more easily the former, possibly owing to its porosity; (2) caoutchouc may itself be rendered radio-active (Mme. Curie); (3) the decay of activity of caoutchouc in air does not follow the usual law for solid substances. L. H. W.

736. *Radio-active Emanations in the Atmosphere.* **A. Gockel.** (Phys. Zeitschr. 5. pp. 591–594, Oct. 1, 1904.)—Observations were carried out on the radio-activity of the atmosphere at the place of residence of the author at Freiburg, in Switzerland, during the ten months preceding mid-August, 1904. The method and apparatus used were similar to those of Elster and Geitel, and the results obtained were in general agreement with those of these authors. The value obtained for the constant A, which expresses the activity about mid-day, was 84, which is 4½ times greater than the value found by Elster and Geitel in Wolfenbüttel, and closely approaches that of 91 found by Saake at Arosa in the months February till April. Whilst Elster and Geitel observed A = 137 in the Bavarian Alps, the value in the island Juist, in the North Sea, was 6. The highest value of the constant observed by the author of this paper was A = 420, during the period of the Föhn [the moist south wind which sometimes prevails in Switzerland]. He suggests that the physiological action of the air of high altitudes, especially perhaps the tanning of the skin, may be partly due to the presence of radio-active emanations in the atmosphere. J. J. S.

737. *Radio-activity of Mineral Springs.* **G. A. Blanc.** (Phil. Mag. 9. pp. 148–154, Jan., 1905.)—The author gives an account of an investigation of the radio-active properties of mineral and thermal waters from various sources in the Alpine region, making use of an apparatus similar to that used by Sella. The results are given in a table, and the author points out that besides the activity and emanation attributable to traces of radium, some

deposits contain a constituent which, from its rate of decay and capability of producing excited radio-activity falling to half in 11 hours, is probably thorium.
L. H. W.

**738.** *New Radiferous Mineral.* **J. Danne.** (Comptes Rendus, 140. pp. 241–243, Jan. 23, 1905.)—In certain lead-bearing soils near Issy-l'Evêque, radium is found which is not accompanied by uranium. The minerals containing the radium are pyromorphite, some lead-bearing clays, and some pegmatites, but oftenest pyromorphite. Radio-active gases have been extracted from the water of the district, the activity being due to the presence of radium emanation. The precipitate obtained from large quantities of the water is feebly but permanently radio-active. 1,000 kg. of the mineral may produce about a centigramme of radium bromide.
G. E. A.

**739.** *Radio-activity of Sediments from Thermal Springs.* **J. Elster** and **H. Geitel.** (Archives des Sciences, 19. pp. 5–30, Jan., 1905. Paper read before the Verein für Naturwissenschaft zu Braunschweig, Dec. 1, 1904. Translated from the German.)—The following table shows the relative rates of decay of the induced radio-activity produced by the emanation from (1) radium, (2) the sediment from Baden-Baden, and (3) that from Nauheim :—

| Time. | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 min. |
|---|---|---|---|---|---|---|---|---|
| (1) | 92·3 | 78·0 | 62·7 | 48·7 | 36·9 | 27·5 | 20·3 | 14·8 |
| (2) | 88·6 | 78·0 | 66·1 | 55·9 | 44·7 | 36·2 | 29·4 | 26·4 |
| (3) | 89·7 | 78·0 | 62·8 | 54·5 | 45·7 | 38·0 | 31·5 | 27·6 |

The two sediments thus behave in a very similar manner, but the rate of decay is much smaller than in the case of radium, and approximates to that of a mixture of radium and thorium. A partial fractionation of the Baden-Baden sediment was effected, and a fraction was obtained which showed a decay of activity represented by the formula $I = I_0 \,.\, e^{-0{\cdot}06242t}$, the index for thorium being 0·06236. The barium sulphate fraction approximated somewhat to the behaviour of radium salts, but the results were by no means identical. Further fractionation of this part of the sample resulted in the separation of a further quantity of thorium, but the quantity of material available was too small to allow of a complete separation of radium. It is possible, however, that the difference in behaviour is due to the presence in the sediment of a third radio-active substance relatively rich in $\beta$-radiation, but giving an emanation similar to that of thorium. T. M. L.

**740.** *Radio-activity of the Common Metals.* **A. Righi.** (N. Cimento, 9. pp. 53–64, Jan., 1905. From. R. Accad. delle Scienze, Ist. di Bologna, T. 1, Serie 6.)—The experiments of Strutt [see Abstract No. 1374 (1903)] and of McLennan and Burton [see Abstract No. 1936 (1904)] have shown that the ordinary metals render the air in their neighbourhood conducting. In order to verify this effect, and if possible to determine whether or no the metals are rendered radio-active by some emanation in the air, and whether the air is rendered conducting by a radiation from without, the author has repeated the above experiments, using as a conductor from which the charge leaks, the electrometer itself. This takes the form of a small gold-leaf electroscope, and since conductor and electroscope are in one piece, the capacity is very small, and the determinations may be more rapidly made than is ordinarily the case. Instead of air, carbon dioxide is used. A disc of the metal to be examined is enclosed with the electroscope in a glass vessel, and it is found that, in the case of most metals, the charge which is given to the electroscope slowly leaks away. The leaking takes place most rapidly in the case of lead and bismuth. The author believes that he has established the fact that most of the common metals are radio-active, either on their own account or because of an emanation present. In the case of lead the effect diminishes after the first quarter of an hour, probably owing to the formation of an oxide on its surface. The same effect, though less marked, is observed in the case of zinc. S. G. S.

741. *Radio-activity of Underground Air.* **H. M. Dadourian.** (Amer. Journ. Sci. 19. pp. 16–22, Jan., 1905. Phys. Zeitschr. 6. pp. 98–101, Feb. 15, 1905.)—It is known that the activity of the radio-active gas present in the air decays at the same rate as that of radium emanation, but the excited activity does not agree very well with the result that would be expected if the activity is due to radium. Bumstead has shown that the presence of thorium emanation as well as radium would explain this [see Abstract No. 2560 (1904)]. The author shows that a similar explanation would suffice for the activity of underground air. It is not, however, complete; the outstanding differences are yet under investigation. R. S. W.

742. *The Radiation from Radium.* **L. Matout.** (Le Radium, No. 1. pp. 6–14, July, 1904.)—A general paper dealing with the examination of the different actions of the radiation by (1) phosphorescence methods, and (2) the magnetic field. An experimental arrangement of Becquerel's, comprising two concentric cylindrical lead screens provided with small openings at different places, the radium, being in the interior of the inner screen, is recommended as a convenient photographic method of studying the absorptive power of a screen for rays of a definite velocity. Illustrations are given showing the results obtained. L. H. W.

743. *Origin of Radium.* **F. Soddy.** (Nature, 71. p. 294, Jan. 26, 1905.)—Referring to his previous note on the production of radium from uranium salts [see Abstract No. 1821 (1904)], Soddy points out that his statement that the radium observed as produced from uranium was less than $\frac{1}{10000}$th of the amount to be theoretically expected was made in error. He now finds that it is highly probable that there is a steady production of radium from uranium, and although the amount formed as measured from the emanation evolved is of a lower order of magnitude than is indicated by the disintegration theory, it is much greater than the $\frac{1}{10000}$th part, and is about $\frac{1}{500}$th of the expected value. The error arose from the presence of extraneous radium in the laboratory, which made the readings of the radium emanation, with which the action of the radium evolved from uranium was compared, too large. **W. C. D. Whetham.** (Ibid. p. 319, Feb. 2, 1905.)—The quantity of radium emanation evolved by a uranium salt is found to be appreciably greater than at first. It is suggested as possible that a non-radio-active product, intermediate between uranium and radium, may exist. The rate of appearance of radium would then be slower at first and quicker as the experiment proceeds. J. J. S.

**744.** *New Radio-active Product from Actinium.* **T. Godlewski.** (Nature, 71. pp. 294–295, Jan. 26, 1905.)—This note gives a preliminary account of experiments which show that actinium is capable of giving rise to a product analogous to UrX in uranium or ThX in thorium. The product AcX immediately after its separation (by the method used for producing ThX) was, weight for weight, a hundred times more active than the original actinium. The activity first increased and then decreased, according to an exponential law, falling to half its value in about ten days, the constant of change being characteristic. The product AcX gives out $\alpha$- and $\beta$-, and probably also $\gamma$-rays. The activity from ordinary actinium appears to be entirely due to AcX and its successive products. J. J. S.

**745.** *Slow Transformation Products of Radium.* **E. Rutherford.** (Nature, 71. pp. 341–342, Feb. 9, 1905.)—A continuation of the work, of which an account is given in Abstract No. 81 (1905). The conclusions there arrived at are confirmed and extended. Radio-tellurium and radium E are shown to be identical, and there is little doubt that they are the same substance as polonium. Each gives out $\alpha$-rays only, can be deposited on a bismuth plate placed in the active solution, and, as far as concerns the first two, decays to half value in 150 days instead of one year as previously calculated (*loc. cit.*). The rate of decay of polonium needs to be determined more accurately. The product radium D has been more carefully examined, and is found to contain two distinct substances. Radium D itself gives out no rays at all, but changes into a substance which gives out only $\beta$-rays, and is half transformed in 6 days. This product is named radium $D_1$, tentatively. $D_1$ gives rise to E (polonium). The conclusion that D is half transformed in 40 years still holds good. The substance separated chemically from radio-lead by Hofmann [Abstract No. 3205 (1904)], which gives out $\beta$-rays only, and loses much of its activity in 6 weeks, is most probably $D_1$. R. S. W.

**746.** *Positive Charge on $\alpha$-Rays and Emission of slowly moving Kathode Rays by Radio-active Substances.* **J. J. Thomson.** (Cambridge Phil. Soc., Proc. 13. pp. 49–54, Feb. 18, 1905.)—The positive charge of the $\alpha$-rays is transferred to a conductor and detected by the electrification of that conductor, while, in addition, it is discovered that radio-active substances emit large numbers of low velocity kathode rays. A sheet of bismuth on which polonium has been deposited is placed near the leaves of an electroscope, in a vessel very highly evacuated by means of Dewar's charcoal method. The distance between disc and leaves is 4 cm. A magnetic field of 1,200 units can be created parallel to the plate. The leaves are charged alternately positively and negatively, and their rate of fall observed both with the magnet on and off. If the $\alpha$-rays are charged positively it is to be expected that the leak would be quicker with a negative charge; but the exact opposite is the case, for a large leak is obtained with a positive charge, and this can be almost entirely stopped by the magnetic field. With a negative charge a small leak is found, and the magnet has no effect on this. This shows that the polonium emits kathode rays of small velocity, and renders it probable that the positive charge on the $\alpha$-rays is neutralised by passage through this stream. By placing the plate 1 mm. away from the leaves a much greater leak is obtained when they are charged negatively than when positively, the magnet being on in both cases, showing that the $\alpha$-rays are positively charged. The discovery of the slow kathode rays may have an important bearing on the transformations which radio-active matter undergoes. Similar results are given by radium. [See also next Abstract.] R. S. W.

**747.** *Positive Charge of α-Rays.* **E. Rutherford.** (Nature, 71. pp. 413–414, March 2, 1905. Elect. Rev., N.Y. 46. p. 490, March 25, 1905.)—Having only seen Thomson's paper [see preceding Abstract] in abstract, the author knows of the discovery of slow kathode rays but not of the demonstration of the charge on the α-rays. Using a method identical with that of Thomson, the positive charge of the α-rays is shown. Assuming that this is the same as that on a gaseous ion, it is calculated that 1 gm. of radium bromide emits $8{\cdot}5 \times 10^{10}$ particles per sec. when at its minimum activity, and four times this number when in radio-active equilibrium. By special experiments, which are not given, the number of β particles emitted is found ($8{\cdot}5 \times 10^{10}$). **J. J. Thomson.** (Ibid. p. 438, March 9.)—Thomson points out, in reply to Rutherford, that he has already shown that the α-rays are positively charged, and adds that since publication of his paper on the subject [preceding Abstract], he has found that uranium also gives out slow kathode rays. **F. Soddy.** (Ibid. pp. 438–439, March 9, 1905.)—Soddy thinks that the experiments of Rutherford prove that the α-rays are charged positively under ordinary conditions, but does not consider it established that they possess this charge at the moment of expulsion. He thinks it possible that they acquire this charge afterwards by losing one of their negative electrons. R. S. W.

**748.** *Improved Methods of Applying Radium.* **H. Lieber.** (Soc. Chem. Ind., Journ. 24. pp. 230–231, March 15, 1905.)—The α-rays of radium, as well as the emanations, are practically unavailable for therapeutic purposes when used in glass tubes, owing to their small penetrative power. Even the superficial layers of a radium salt are relatively impervious to both the emanations and the α-rays from the underlying portions. The author has been working to obtain the radium in such a form that both these drawbacks should be non-existent. This led to the production of "radium coatings." These are made by dissolving the radium in a suitable solvent, and into this solution a suitable material to be coated is dipped. (For celluloid objects, alcohol and amyl acetate.) To prevent removal of the radium coating, a thin film of collodion may be applied. This film permits the α-rays and emanations to pass freely. A delicate rod coated at its tip with radium bromide of 10,000 activity was comparable as regards effect on the electroscope with 1 gm. of radium bromide of the same activity in a glass tube, or with 10 mgm. of radium bromide of 1,000,000 activity in a thin aluminium tube. L. H. W.

## REFERENCES.

**749.** *Potsdam Spectroheliograph.* **P. Kempf.** (Zeitschr. Instrumentenk. 24. pp. 317–322, Nov., 1904. Astrophys. Journ. 21. pp. 49–54, Jan., 1905.)—A detailed description of the spectroheliograph which has been in use at the Potsdam Astrophysical Observatory for some years. It consists of two parallel tubes forming collimator and camera of a grating spectroscope, the whole arranged to slide across the optical axis of the photographic refractor on the plan devised by Hale. C. P. B.

**750.** *Infra-red Spectra of the Elements.* **H. Lehmann.** (Phys. Zeitschr. 5. p. 823, Dec. 15, 1904. Phys. Inst. der techn. Hochschule, München, Nov., 1904.)—The infra-red spectrum has been penetrated as far as 1,700 μμ by means of a phosphoro-photographic method, rubidium having lines in the neighbourhood of 1,700 and of 1,400 μμ. Potassium has some strong lines near 1,250 μμ, and sodium near 1,150 μμ. [See also Abstracts Nos. 1880 (1901) and 57, 425 and 898 (1903).] G. E. A.

751. *Rotation Sector with Variable Motion.* **E. Brodhun.** (Zeitschr. Instrumentenk. 24. pp. 313–317, Nov., 1904. Communication from the Physikal. Technische Reichsanstalt.)—The author describes in detail a new rotation sector with adjustable aperture and motion, for use in photometrical determinations.
C. P. B.

752. *Theodolite-Goniometers.* **C. Klein.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 2. pp. 94–101, Jan. 19, 1905.)—It is described how the crystal-polymeter [see Abstract No. 1636 (1900)] may be changed into a theodolite- or three-circle-goniometer, the advantages of the latter instrument for making measurements on crystals being set forth. G. E. A.

753. *Does the Ether Move with the Earth?* **A. Schweitzer.** (Phys. Zeitschr. 5. pp. 809–811, Dec. 15, 1904.)—Following the suggestion of W. Wien, the present author describes a modification of Fizeau's method by which it is hoped to settle the question whether or not the ether moves with the earth. [See also Abstract No. 360 (1905).] E. H. B.

754. *Zonal Corrections in Refractors.* **K. Strehl.** (Zeitschr. Instrumentenk. 24. pp. 322–326, Nov., 1904.)—An analysis is given of the distribution of errors of objectives by considering those of given zones, and then forming the integrated effect, with tables of results from measurements of definite lenses. [See also Abstracts Nos. 205 (1903) and 2861 (1904).] C. P. B.

755. *Modern Physics in Relation to Photographic Optics.* **R. T. Glazebrook.** (Photographic Journ. 45. pp. 43–53, Jan.–Feb., 1905. 7th Traill Taylor Memorial Lecture. Engineering, 78. pp. 862–863, Dec. 23, 1904. Abstract.)—The result of the application of theory to practice is contrasted with the efforts at progress along empirical lines, both being exemplified in the history of the photographic lens, the principal facts of which are given. The defects of a lens and their cure are then described, and the necessity for the combination of physical science, technical knowledge, and manipulative skill is emphasised. G. E. A.

756. *Ellipsoid of Absorption in Crystals.* **J. Boussinesq.** (Comptes Rendus, 140. pp. 401–405, Feb. 13, 1905.)—A mathematical consideration in which it is shown that in every transparent crystal such an ellipsoid exists even if there be no plane of symmetry or principal axis. J. W. P.

757. *Spectroscopic Photography in Colour.* **T. T. Baker.** (Photographic Journ. 45. pp. 24–28, Jan.–Feb., 1905.)—An outline is given of the procedure to be employed in photographing spectra, the adjustment of filters to plates being more particularly dealt with. An apparatus is described which is employed in standardising the intensity of the colour of each stained film. The rays from three equal, enclosed sources of light pass through the films and through three slits respectively, and combine on a screen in front. The slits are adjusted until the illumination of the screen is white. G. E. A.

758. *Photographic Activity of Ozone.* **K. Schaum.** (Phys. Zeitschr. 6. pp. 73–74, Feb. 1, 1905. Phys. Inst. Marburg.)—A short *résumé* is given of the progress under this head since the observation of Niepce de St. Victor, in 1859, that certain substances, notably paper and metal plates, become photographically active after insolation. The disagreement between the results of Graetz [see Abstract No. 532 (1905)] and those of the author is explained from the fact that different makes of plates, even when from the same factory, exhibit wide differences in their sensitiveness to ozone, those used by Graetz being probably insensitive, whereas with certain makes reversal takes place after 8 min. exposure to ozone. G. E. A.

## HEAT.

**759.** *Modification of Bunsen's Ice Calorimeter.* **V. Crémieu.** (Journ. de Physique, 4. pp. 105–109, Feb., 1905. Paper read before the Société Franç. de Physique, Jan. 6, 1905.)—The arrangement of Bunsen's ice calorimeter is so modified that the progress of an experiment can be watched by an audience. Instead of using a capillary tube along which the mercury travels, the mercury is caused to issue in drops from a capillary tube into a transparent flat vessel containing water. This can be projected on to a screen so that the formation of the drops can be followed. The apparatus is calibrated in terms of cals. per drop of mercury, it being assumed that all the drops are of one size. The usual jackets surrounding the calorimeter are replaced by a Dewar vacuum vessel. The determinations of the value of the mechanical equivalent of heat and the performance of Joule's experiment on the cooling effect due to the expansion of a gas are described. S. G. S.

**760.** *Heat given out by Radium.* **K. Ångström.** (Ark. för Mat. Astron. och Fysik, Stockholm, 1. Nos. 3–4, pp. 523–528, Dec. 13, 1904.)—Using 100 mgm. of specially pure radium bromide, the author found that 1 gm. of radium bromide gives out 1·14 cals. per min. or 68·5 cals. per hour, so that 1 gm. of pure radium would give (taking the atomic weight of radium as 225) 117 cals. per hour (or 110 cals. for atomic weight 258). These values are somewhat higher than those obtained by Precht. In 7 months the radium gave off altogether 345,000 cals. per gm. [see Abstract No. 1084 (1904)]. L. H. W.

**761.** *Cooling Power of a Stream.* **J. Boussinesq.** (Comptes Rendus, 140. pp. 65–70, Jan. 9, 1905.)—In a current of air Newton's law of cooling holds for differences of not merely 10° or so, as in still air or a vacuum, but of 300°. [Indeed, Newton gave it only for this case: see Abstract No. 853 (1902).] The cooling power of the stream may thus be expressed as a fictitious external conductivity of the body cooled, and it is proportional to $\sqrt{(KCV/L)}$, where L is the length of a stream-line on the body and K, C, V are the magnitudes named in Abstract No. 2246 (1904) [where the proportionality for similar bodies should be to the *square root* of the volume]. The coefficient of proportion is $2/\sqrt{\pi}$ for a thin plate placed parallel to the current, this being its smallest value; it is $2\sqrt{(c/\pi p)}$ for an indefinitely long elliptic cylinder with its axis perpendicular to the current, $c$ being the sum of its axes and $p$ its perimeter; $\sqrt{2}$ for a sphere; $8/\pi\sqrt{3}$ for a circular disc perpendicular to the stream; $8\sqrt{(2/3\pi^3)}$ for a long needle. R. E. B.

**762.** *Employment of Radium for Proving the Law of Radiation of Heat at Low Temperatures.* **E. Bose.** (Phys. Zeitschr. 6. pp. 5–6, Jan. 1, 1905.)—A thick-walled platinum sphere, blackened on the outside with platinum black, contains a predetermined quantity of radium bromide, sufficient in amount to maintain the temperature of the platinum sphere a definite number of degrees above that of the spherical glass enclosure in which it is situated, when the temperature of the latter is 0° C.; the three differences in temperature employed are: 0·1°, 1·0°, and 7·0°. After any change in the temperature of the glass enclosure, the temperature of the sphere containing the radium salt slowly approaches some fixed limit, called the convergence temperature. This convergence temperature is determined for various temperatures of the enclosure, but the actual temperatures used in the experiment are not given. Curves are plotted, showing the convergence temperatures for different temperatures of the enclosure; they are continued down to the absolute zero of temperature. The experiments were undertaken with the object of proving Stefan and Boltzmann's law at low temperatures, but the comparison of calculated with observed results is not given; the curves, however, are exceedingly regular. It is assumed that the rate of production of heat by the radium salt is independent of the temperature; and the method of determining the requisite amount of radium salt to produce any desired convergence temperature is given. Should the truth of Stefan's law be assumed, then any observed deviations from it may be used for the purpose of determining the thermal conductivity of the gas in the enclosure. S. G. S.

763. *The Joule-Thomson Effect in Carbon Dioxide.* **F. E. Kester.** (Phys. Zeitschr. 6. pp. 44–50, Jan. 15, 1905. Translated from the English.)—The porous plug experiment is repeated with $CO_2$, previously tested for purity, and the apparatus employed is described at length. The only point in which it differs essentially from Joule and Thomson's apparatus is in the use of thermo-couples for the determination of the difference of temperature on the two sides of the plug. The experiments were all carried out at temperatures between 20·4° and 24·4° C., the results being reduced to 22°. The relation found is $\delta\theta/\delta p = 1{\cdot}187^\circ + 0{\cdot}0015p$ within an error of 2·5 per cent. A short discussion of the dependence of the effect upon the absolute pressure, as obtained by van der Waals' equation, is given. S. G. S.

764. *Coefficient of Expansion of Nickel at its Critical Temperature.* **H. M. Randall.** (Phys. Rev. 20. pp. 85–88, Feb., 1905.)—Using the method employed for the determination of the coefficient of expansion of quartz [see Abstract No. 550 (1905)], the author has determined the coefficient of expansion of nickel at temperatures up to 392° C. The coefficient of expansion rises until a temperature of about 280° is reached, and then becomes sensibly constant at 0·0000164, up to 392°, at which temperature it again shows a slight tendency to rise. The anomalous expansion between 365° and 370° as found by Harrison when experimenting on a nickel wire [see Abstract No. 2204 (1904)] was not observed by the author. Further experiments with a carefully annealed cylinder of nickel are to be undertaken. S. G. S.

765. *Specific Heat of Gases at High Temperatures.* **L. Holborn** and **L. Austin.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 5. pp. 175–178, Feb. 2, 1905. Communication from the Physikal.-Techn. Reichsanstalt.)—The experiments were undertaken with the object of bridging the gap in our knowledge of the specific heats of gases which occurs between the temperatures of 200° and 1,000° C. Below 200° Regnault's values are generally used, while the values for very high temperatures are deduced from explosion experiments. The method of mixture at constant pressure is employed, but the gas does not come directly in contact with the water in the calorimeter on account of the solubility of some of the gases; it passes instead into an indiarubber bag. The temperature is determined by means of a thermo-couple of platinum and

platinum-rhodium as the gas enters the calorimeter. The following table gives the mean specific heats for three gases :—

| | Nitrogen. | Oxygen. | Air. |
|---|---|---|---|
| 20° to 440° C.......... | 0·2419 | 0·2240 | 0·2366 |
| 20° to 630° ......... | 0·2464 | 0·2300 | 0·2429 |
| 20° to 800° ......... | 0·2497 | — | 0·2430 |

The specific heat of carbon dioxide is also determined and compared with the results of Regnault, Wiedemann, and of Mallard and le Chatelier.

S. G. S.

766. *Heat of Vaporisation of Liquid Air.* **R. C. Fenner** and **F. K. Richtmyer.** (Phys. Rev. 20. pp. 77–84, Feb., 1905.)—Heat is supplied electrically to the liquid air, whose temperature and rate of evaporation are observed. It is found that the heat of vaporisation is practically constant for all percentages of oxygen from 20 to 97, when it begins to show signs of rising. This constancy is surprising, as the value for oxygen is 61·0 cals. per gm., and for nitrogen 49·2, and the temperature at which liquid air boils changes with its composition. An explanation depending on the differences of the specific heats of oxygen and nitrogen in the liquid and gaseous states is given, the necessary data being taken from Baly's curves [see Abstract No. 1884 (1900)]. It is also pointed out that as the percentage of oxygen increases the boiling-point rises, and heat is necessary to produce this change in temperature of the liquid. A corrected curve is drawn in which this source of loss is allowed for. Since this effect diminishes as the temperature rises, it follows that if the heat of evaporation appears to remain constant it is really rising as the percentage of oxygen increases. S. G. S.

767. *Acoustic Determination of Vapour Densities.* **R. Wachsmuth.** (Deutsch. Phys. Gesell., Verh. 7. 2. pp. 47–48, Jan. 30, 1905. Boltzmann Festschrift, pp. 923–928, 1904.)—The change in pitch of a small metal pipe when sounded in a vapour instead of air is determined by means of a comparison pipe, the densities of the two media varying, within certain limits, inversely as the squares of the frequencies. The liquid is evaporated in a bath at a temperature 20° or 30° above the boiling-point of the liquid, and the vapour given off surrounds, heats, and sounds the pipe. G. E. A.

768. *Theory of the Incandescent Mantle.* **V. B. Lewes.** (Chem. News, 91. pp. 62–66, Feb. 10, 1905.)—The history of the application of the rare earths to gas lighting and the work of A. v. Welsbach is dealt with. The necessary qualifications of the mantles are discussed, and the emissivity of zirconia, thoria, ceria, lanthana, yttria, erbia, chromium oxide, alumina, baryta, strontia, and magnesia are compared. The author has favoured the catalytic theory which he discusses, and compares with the theory of selective radiation. Recent research on the subject is detailed, and the evidence of le Chatelier, Nernst, Schmidt, and others is accepted—that catalysis, temperature, and selective radiation all play their part in bringing about the increased light emissivity. W. W. H. G.

**769.** *Kinetic Theory of the Dependence of Gaseous Density on External Force.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 1289–1302, Nov., 1904. Ann. d. Physik, 16. 1. pp. 46–60, Jan. 26, 1905.)—This continuation of a former paper [see Abstract No. 123 (1904)] proceeds on the same lines, making the same implicit assumptions, and consequently avoiding the special difficulties of the investigation in the same way; and the conclusion is reached that the Maxwell-Boltzmann law holds good, not merely when the field of action of the external forces is large, so that very many molecules are contained in it, but also when the external forces act over very small regions, so that but very few molecules are involved—as in the cases of viscosity, dissociation, &c. The conclusion is obtained by considering the circumstances of the molecules between two very near planes (like the plane AB in the former paper) which have exactly opposite effects upon the molecules. R. E. B.

**770.** *Internal Energy of Gas-liquid Systems.* **A. Schükarew.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 9. pp. 281–365, 1904. Univ. of Moscow.)—The author has found the means of sealing different liquids in steel capsules, or "sparklets," provided with a spiral capillary of pure platinum; these capsules stand great pressure, and hence the author has been able to heat the liquids in them to the critical and higher temperatures, and to determine the specific heats at these temperatures. The internal energy can then be calculated if one knows the heat of condensation of the superheated vapours of the liquids investigated; for some of the liquids used the experimental data necessary for the calculation were known; in the case of others they were obtained by the author, who devised two satisfactory calorimetric methods for the purpose. The results obtained may be applied to the testing of van der Waals' equation in two ways, viz., (1) by making isothermals of the internal energy, (2) by the formulæ—

$$Q_0 - Q = \frac{a}{A}\left(\frac{1}{v} - \frac{1}{v_0}\right) \ldots\ldots(1), \qquad (Q' - Q)v = \frac{a}{A} = \text{const.} \ldots\ldots(2).$$

Both methods are adopted by the author. The examination of the author's isothermal curves leads to the following conclusions (these may be considered as a *résumé* of the investigation): (1) For the pre-critical region (which concerns two-phase, gaseous-liquid systems) the isothermals of internal energy are generally curved towards the axis of the abscissæ. This curvature forms at low temperatures, a sort of angle; at temperatures near the critical the angle passes into a simple arching or curvature. (2) For all substances examined by the author, viz., isopropyl alcohol, methyl alcohol, acetone, ethyl ether, tertiary amylene, and isopentane, the curvature of the curves of internal energy towards the axis of abscissæ is preserved, not only at the critical temperature, but also considerably above it. Thus for ether and isopentane it is clearly perceptible at 217°. (3) With increase of temperature this positive curvature towards the axis of abscissæ changes into a negative one away from the axis—the curves become convex towards the axis. (4) Hence it follows that for every body there exists one perfectly definite temperature (which the author proposes to call the "van der Waals' temperature"), at which the change of internal energy with change of concentration, follows van der Waals' equation strictly, *i.e.*, is expressed by a straight line. (5) For the substances investigated by the author, the van der Waals' temperature lies considerably above the critical temperature. For ether it is about 240°, for isopentane about 300°. (6) The degree of curvature of the curves of internal energy at the critical temperature is in general different for the different substances, just as the rate of transition into the opposite curvature and the degree of the latter also vary. (7) The expression which van der Waals gives for the internal energy is merely a special case, viz., that corresponding to the van der Waals' temperature. D. H. J.

**771.** *Laws of Straight Diameters and of Corresponding States.* **E. Mathias.** (Journ. de Physique, 4. pp. 77–91, Feb., 1905.)—If a substance conforms to the law of straight diameters, the mean of the reduced saturation-densities of its liquid and vapour phases at reduced temperature $\tau$ is given by $\delta - 1 = a(1 - \tau)$, where $a$ is a constant; and for any such substances which also conform to the law of corresponding states $a$ must be the same. But examination of the data for 37 substances which approximately conform to the former law show variations of $a$ from 0·236 (for hydrogen) to 1·090 (for ethyl propionate), so that the latter law is not applicable to them as a whole, though for 31 of the substances $a$ lies within the limits $0·986 (1 \pm 0·105)$, and they may be divided into *groups* which have corresponding states. The author thinks that they can be more markedly arranged in *series*, for each of which $b \equiv a/\sqrt{\Theta}$ has approximately the same value, $\Theta$ being the critical temperature: for the several series including 30 of the substances $b$ lies between 0·0372 and 0·0469 [*i.e.*, in the range $0·042 (1 \pm 0·115)$, so that the series-arrangement is not really more marked], while extending to 0·0356 (for benzene iodide) and 0·063 (for ethylene). He also concludes that $\Theta$ for the substances in the group corresponding to any value of $a$ lies in the range $(1 \pm \frac{1}{2}) 586a^2$ [though on no convincing grounds], and then discusses this division of bodies into groups and series. [See Abstract No. 2932 (1904).] R. E. B.

**772.** *Calculation of van der Waals' Constants.* **E. Haentzschel.** (Deutsch. Phys. Gesell., Verh. 7. 3. pp. 61–62, Feb. 15, 1905. Ann. d. Physik, 16. 3. pp. 565–573, March 14, 1905.)—Van der Waals' equation being put in the form $(p + av^{-2})(v - b) = (1 + a)(1 - b)\,T/273$, and $\pi$, $\tau$ being the critical pressure and temperature, $a = 27\pi b^2$ and $b$ is the real root of the equation $\alpha(b^3 - b^2) + \beta b - 1 = 0$, where $\alpha \equiv 27\pi$ and $\beta \equiv 1 + 2184\pi/\tau$, and this is very approximately equal to $(\beta^2 + \alpha)/(\beta^3 + \alpha)$. R. E. B.

## REFERENCES.

**773.** *Temperature Regulators.* **W. H. Sodeau.** (Soc. Chem. Ind., Journ. 23. pp. 1134–1136, Dec. 15, 1904.)—Describes (1) a steam regulator with expanding tube of zinc and modifications effected by the author; (2) an electromagnetic steam regulator; (3) an improved electric contact thermometer; (4) a simple regulator for use with large gas-burners; (5) a highly sensitive modification of Novy's gas regulator. Details of the above, and the result of trials with them, are given. It is remarked that Scheibler's electromagnetic gas regulator is in many respects an ideal one for accurate work. W. W. H. G.

**774.** *Apparatus for Thermal Conductivity.* **G. F. C. Searle.** (Phil. Mag. 9. pp. 125–129, Jan., 1905.)—The apparatus is suitable for ordinary laboratory students. The method employs the steady flow of heat along a copper bar cooled at one end by a measured flow of cold water. The temperature gradient is also measured, and so data for the conductivity are given. J. W. P.

775. *High Temperature Measurements.* **T. Gray.** (Soc. Chem. Ind., Journ. 23. pp. 1192–1197, Dec. 31, 1904.)—General; thermoelectric method; platinum resistance thermometer; optical pyrometers (Wanner only). Mainly descriptive.

776. *Fusion of Refractory Materials.* **J. T. Dunn.** (Soc. Chem. Ind., Journ. 23. pp. 1132–1134, Dec. 15, 1904. Paper read before the Newcastle Section, Oct. 20, 1904.)—Deals with the melting-points of furnace materials. The author has used *Seger cones,* and as a furnace Fletcher's "oxygen-injector" type. He lines the furnace with magnesia, and usually works with a crucible provided by the Laboratorium für Tonindustrie at Berlin. The method adopted is described. Three or four experiments can usually be made in an hour. W. W. H. G.

777. *Vapour Pressure by Air-bubbling.* **E. P. Perman.** (Journ. Phys. Chem. 9. pp. 36–39, Jan., 1905.)—As objections have been made by Carveth and Fowler [see Abstract No. 2351 (1904)] to the accuracy of the author's method [see Abstract No. 1262 (1904)] for determining vapour pressures of water and solutions, the author defends his method by quoting some results which show that if the necessary precautions are taken, the method is reliable. He also points out some possible sources of error in Carveth and Fowler's work. A. F.

778. *Vapour-density Determination.* **M. Reinganum.** (Deutsch. Phys. Gesell., Verh. 7. 4. pp. 75–76, Feb. 28, 1905.)—A modification of Hofmann's apparatus is described, the measuring tube being doubled in parallel, so that the mercury level in the one to be read should be free from glass bottles or *débris.* The two tubes end in a cylindrical chamber provided with a stop-cock. R. E. B.

779. *Thermodynamic Graphics.* **G. Belluzzo.** (N. Cimento, 8. pp. 196–222, Sept., and pp. 241–263, Oct., 1904.)—Mathematical and graphic paper on elementary theory, graphic theory of gases, graphic theory of saturated water vapour, and graphic theory of superheated water vapour. Does not lend itself to abstracting. A. D.

780. *Difficulties in Thermodynamics.* **E. Buckingham.** (Phil. Mag. 9. pp. 208–214, Feb., 1905.)—Orr's contention [see Abstract No. 130 (1905)], that the only proof we have of Clausius' inequality is derived from experience, is here maintained, but the adoption of a Third Law, declaring the essential negativeness of $\int dQ/\theta$ for an irreversible cycle, is preferred to any modification of the statement of the Second Law in order to make it include this principle. The use of thermodynamic potentials, in preference to Carnot cycles, in the consideration of problems is vindicated. R. E. B.

781. *Determination of the Melting-point Curve of a Binary Mixture.* **S. Scharbe.** (Ann. d. Physik, 15. 5. pp. 1046–1047, Dec. 23, 1904.)—The author shows how calorimetric measurements may be employed to help in this determination. R. E. B.

782. *More Exact Equation of State for Gases.* **J. B. Goebel.** (Zeitschr. Phys. Chem. 50. pp. 238–240, Dec. 16, 1904.)—The author calculates the values of the specific attractions for a number of hydrocarbons, organic chloro-derivatives, and amines, firstly from the value of the constant *a* of van der Waals' equation, and secondly from the compositions of the compounds by means of empirical coefficients. The numbers arrived at by these two methods show good agreement in all cases. [See also Abstracts Nos. 1718 and 3228 (1904).] T. H. P.

## SOUND.

783. *Open Organ-Pipe.* **Rayleigh.** (Phil. Mag. 8. pp. 481–487, Oct., 1904.)—A mathematical treatment of the problem of the open pipe in two dimensions. If the wave-length or pipe-length be given, the mouth or open end may be treated more and more accurately as a loop, as the width is diminished without limit. Both parts of the pressure variation, corresponding the one to inertia and the other to dissipative escape of energy, ultimately vanish. J. W. P.

784. *Analysis and Synthesis of Vibrations.* **E. Grimsehl.** (Phys. Zeitschr. 4. pp. 748–751, Oct. 24, 1903. Paper read before the 75 Naturforscherversamml. at Cassel, Sept. 23, 1903.)—The method consists in allowing to pass through the holes of the rotating siren disc, a beam of light. This makes an intermittent record on a moving photographic plate. The essential parts are a telescopic arrangement and a Nernst lamp. A variety of photographic reproductions of different cases are given. J. W. P.

785. *Acoustic Investigations.* **H. Sieveking** and **A. Behm.** (Ann. d. Physik, 15. 4. pp. 793–814, Dec. 6, 1904. Phys. Inst. d. techn. Hochschule, Karlsruhe, July, 1904.)—The authors investigate the intensity of vibrations produced in a fork by a similar fork at various distances and under various circumstances. The receiving fork is observed microscopically or photographically, and the emitting fork is actuated electromagnetically. Diminution of intensity with distance, reflections in a closed room, passage of sound through solid and porous bodies are considered. J. W. P.

786. *Velocity of Sound.* **T. C. Hebb.** (Phys. Rev. 20. pp. 89–99, Feb., 1905.)—In order to eliminate the errors attending long-distance determinations of the velocity of sound owing to the variation of the temperature and moisture of the intervening air, the author undertook some interference experiments in the laboratory. Two large parabolic mirrors, made of plaster of Paris, were placed coaxially, so that the waves sent out from the focus of one mirror were concentrated at the focus of the other. In the first focus was placed a source of sound, and near it a telephone transmitter, while another transmitter was placed in the conjugate focus. Each transmitter was connected in series with a battery, and one primary of an induction coil wound with two primaries. A telephone receiver was in series with the secondary of the coil. The waves transmitted by the telephone were made to interfere with those transmitted through the air to the second mirror, and on moving the mirrors apart the alternate maxima and minima were observed. Since the mirror could be moved through 100 waves, and the minima located to within one-tenth of a wave, the value of the wave-length so obtained was accurate to within one part in a thousand. The source of sound was a whistle blown at constant pressure. The velocity obtained was 331·29 m. per sec., which is below the mean of the best previous measurements, viz., 331·75. E. E. F.

# ELECTRICITY AND MAGNETISM.

## THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

**787.** *Oscillating Sparks in Systems of Compound Conductors and the Electrodynamic Theory of Spectral Analysis.* **A. Garbasso.** (N. Cimento, 8. pp. 344–364, Nov., and pp. 393–424, Dec., 1904.)—These two memoirs, with one or more to be published later, will constitute a general treatise on the theory of electric oscillations produced by sparks in systems of condensers—or, as the writer calls them, capacities—connected in pairs by wires, and the application of this theory to spectral analysis. Given a single wire connecting the two plates of a condenser—that is, two "capacities"—let $q$ denote the charge of the positive plate, $i$ the current, we have, as was shown first by Kelvin, a linear differential equation of the second order of the form—

$$(d^2q/dt^2) + A(dq/dt) + B = 0,$$

or writing D for $d/dt$, $D^2q + A\,.\,Dq + B = 0$. This is called the characteristic equation. The writer shows that in the case of a compound system of $p$ capacities connected by $r$ wires we get a linear differential equation, *i.e.*, a characteristic equation of the same form, of an order not higher than $p + r - 1$. He also points out that, as already shown by Rayleigh, the operator may be expressed in the form of a determinant. Then follows a discussion of the solution by symbolical methods of equations of this form, a branch of analysis for which we are mainly indebted, according to the writer, to the English analysts Sylvester, Cayley, and Boole. In the second part is established the general theorem in the following form: In the theory of a compound conductor every charge and every current is determined as a function of the time by one and the same linear and homogeneous differential equation of an order lower by unity than the number of the capacities added to the number of the connecting wires. And this he applies to special cases of one, two, three, four, and five oscillations. In the third part the writer continues the discussion of the general solution, and shows that, on the hypothesis of there being no mutual induction, a certain system of $n$ wires can be represented as regards its oscillations by a single wire. To give an example of the method: In systems of two wires connected with one capacity the writer, employing results given by Cardani, obtains for the characteristic equation the determinant—

$$\begin{vmatrix} R_1 + DL_1 & MD & B \\ MD & R_2 + DL_2 & B \\ 1 & 1 & D \end{vmatrix} q = 0,$$

in which $R_1$ $R_2$ are the resistances of the wires, $L_1$ $L_2$ their self-inductions, M their mutual induction, $B = 2K_{12} - (K_{11} + K_{22})$ and $K_{12}$ denotes the terminal potential of the wire connecting the capacities (1) and (2), &c. This cubic equation has, of course, at least one real root, and the writer shows that it must be negative, and he then discusses the case of the two remaining roots being imaginary. S. H. B.

788. *Oscillating Sparks in Systems of Compound Conductors and the Electrodynamic Theory of Spectral Analysis.* **A. Garbasso.** (N. Cimento, 9. pp. 31–53, Jan., 1905.)—In this theory a substance emitting a spectrum is supposed to consist of a number of resonators—that is, conducting discs—connected by wires. In the fourth part of his work [see preceding Abstract] the author considers a case of somewhat greater complexity than that of two wires dealt with in the beginning of Part III. In the present case we have a system of *n* conductors equal or unequal, each having its "capacities" connected by any number of wires. He applies precisely the same analysis as was applied in the former part, and establishes the theorem: "In any system of compound conductors every charge and every current is determined by a linear and homogeneous differential equation (the characteristic equation), the same for all the variables, the degree of which is obtained by adding the number of the capacities to the number of the wires and subtracting a number equal to the number of conductors of which the system consists." Also that "The degree of the characteristic equation for a system of conductors is the sum of the degrees of the characteristic equations for the separate conductors of which the system consists," which, applied to spectral analysis, gives the result that "A system emits a spectrum which contains, in general, a number of lines equal to the sum of the numbers which appear in the spectrum of the separate conductors composing the system." The author refers to an experiment described in the Atti dell' Accad. di Torino, 1893, in which 186 equal linear resonators were arranged in six horizontal rows without interval on a wooden table, each consisting of two discs connected by a wire, and it was found that the effect produced on the system by an electric force did not materially differ from that produced by a secondary system having a period differing widely from that of the individual resonators. This result is what the analysis leads us to expect. The author goes on to consider various special cases. Dealing with the case of two conductors of any kind, he finds that if they are not too near together, the spectrum they emit differs little from the two separate spectra superposed. He treats also the cases of two conductors with one, two, or three oscillations, then of two equal conductors, for which the analysis leads to the following conclusion: That if two equal and similar conductors mutually influence each other, their spectrum is the same which each separately emits, but with each line replaced by a doublet. If, for instance, the periods corresponding to the lines of the spectrum of the single conductor are functions of the self-induction of the form $T_1(L)$, $T_2(L)$ . . . . $T_m(L)$, those of the corresponding doublets in the spectrum of the combined conductors will be $T_1(L \pm M)$, $T_2(L \pm M)$, &c., and the ratio of the periods of the two lines of the same doublet is for each doublet proportional to $\sqrt{(L+M)/(L-M)}$. Systems of three equal conductors are then treated by the same method. And the result obtained for the two conductors is extended as follows: "If three equal conductors mutually influence each other, their combined spectrum is obtained from the spectrum emitted by each singly by substituting a triplet for each line in that single spectrum." And in general the spectrum of any combined system differs little from that obtained by superposing the spectra of its component parts. S. H. B.

789. *Electric Inertia.* **S. H. Burbury.** (Phil. Mag. 9. pp. 243–250, Feb., 1905.)—In his address on Electrons, O. J. Lodge calculated simply the inertia of a charge *e* moving at a speed *u* [see Abstract No. 1466 (1903)]. The present paper deals with terms of higher order needed when the speed *u* is

not very small compared with that of light. Thus, if the magnetic force H is required at P $(r, \theta)$ due to the charge $e$ at origin S moving along axis at speed $u$; $r$ and $\theta$ must be reckoned from S′, the point occupied by the sphere $t$ seconds previously, where $S'S = ut$ and $S'P = vt$, $v$ being the speed of light. This train of argument is followed up and full expressions obtained for various cases. E. H. B.

790. *The Principle of Energy for Kinetic Potentials of any Order and any Number of Dependent or Independent Variables.* **L. Koenigsberger.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1342–1380, Dec. 8, 1904.)—The Lagrangian formula $\frac{\partial H}{\partial p} - \frac{d}{dt}\frac{\partial H}{\partial p'} = 0$, in which $p'$ denotes $\frac{dp}{dt}$, and $p''$ denotes $\frac{d^2p}{dt^2}$, &c., has been extended by the writer of this article in former works, here referred to, to higher derivatives of H according to $t$, of the form, for instance—

$$\frac{\partial H}{\partial p} - \frac{d}{dt}\frac{\partial H}{\partial p'} + \frac{d^2}{dt^2}\frac{\partial H}{\partial p''} - \dots (-1)^{\nu} \frac{d^{\nu}}{dt^{\nu}}\frac{\partial H}{\partial p^{(\nu)}} = 0,$$

and the method has been applied to systems of many variables, in the writer's notation called parameters, $p_1, p_2, \ldots p_\mu$. The principle of energy discussed in this paper is the equation—

$$\begin{aligned} E = H - \sum_{s=1}^{s=\mu} p'_s \Big(\frac{\partial H}{\partial p'_s} - \frac{d}{dt}\frac{\partial H}{\partial p''_s} + .\ \&c.\\ - \sum_{s=1}^{s=\mu} p''_s \Big(\frac{\partial H}{\partial p''_s} - \frac{d}{dt}\frac{\partial H}{\partial p'''_s} + \&c.\\ - \sum_{s=1}^{s=\mu} p^{(\nu)}_s \frac{\partial H}{\partial p^{(\nu)}_s} = h, \end{aligned}$$

where E is in an extended sense the quantity of energy, and $h$ a constant. The present work is an elaborate discussion of this extended principle, involving the theory of partial differential equations of higher orders. It cannot be made intelligible, nor even can its results be given, without long mathematical calculations. S. H. B.

791. *Magnetic Field of Convection Currents.* **N. Vasilesco-Karpen.** (Annal. Chim. Phys. 2. pp. 465–574, Aug., 1904.)—Full *résumé* of the recent work on the subject. The author, employing the method of investigation of the electromagnetic induction due to convection currents, if any, and making the convection current sinusoidal and tuning the induced system to the inducing system, found that convection currents produce, within experimental errors, the same magnetic effects as equal conduction currents do. The presence of conductors produces the same deadbeat effect in the two cases. The magnetic effect of convection currents may be added to or may counteract that due to conduction currents. Dielectrics produce no effect upon the magnetic action of charges in movement. The conditions under which a charge is borne along by a conductor in movement are discussed. The magnetic action of electric convection is a necessary consequence of Maxwell's equations; but where a charged body is in movement, we *must* complete

Maxwell's equations by introducing into the expression for the total current a term for the convection current. Therefore the work done by magnetic force along a closed contour is equal to $4\pi$ times the total current traversing any surface limited by the same contour; the total current comprising (in the absence of conduction currents) the displacement and the convection current. He concludes that Faraday's conception of lines of force is untenable and unnecessary. It is impossible to obtain any magnetic field due to charged bodies affected by the astronomical movement of the earth. A. D.

792. *Electric Units.* **M. Ascoli.** (Inst. Elect. Engin., Journ. 34. pp. 176–185, Feb., 1905, with appendix by **G. Giorgi.** Paper read before the St. Louis International Electrical Congress, Sept. 12, 1904.)—In the *five* fundamental equations (1) $f = \alpha^{-1}e^2/r^2$, (2) $f = \beta^{-1}m^2/r^2$, (3) $f = \gamma^{-1}mids \, . \sin \omega/r^2$, (4) $f = \delta^{-1}ii' \, ds \, ds'/r^2$, (5) $i = e/t$, we have *seven* magnitudes ($e$, $m$, $i$, $\alpha$, $\beta$, $\gamma$, $\delta$) not of a geometrical or mechanical character, and not depending, therefore, on $l$, $m$, $t$. Length, mass, and time are therefore insufficient to define the electric units; five fundamental magnitudes are necessary, of which $l$, $m$, $t$ may be three, while the other two may be any of the above seven or any other magnitudes connected with these by known equations. It is possible that the future may show $\alpha$, $\beta$, $\gamma$, $\delta$ to be expressible in terms of $l$, $m$, $t$; but at present the suggestion is arbitrary. From the above equations $\gamma^2/\alpha\beta = v^2$, $\delta/\alpha = v^2$, where $v =$ velocity of light. If we suppose $\alpha = \gamma = 1$ (electrostatic system), $\beta^{-1} = \delta = v^2$; if $\beta = \gamma = 1$ (electromagnetic system), $\alpha^{-1} = \delta = v^2$; if $\alpha = \beta = 1$ (Hertzian), $\gamma^2 = \delta = v^2$. For rationalisation in the Heaviside sense (getting rid of $4\pi$ in the formulæ of electromagnetism), Giorgi proposed to supply the two required assumptions by making $\gamma = \pi$ and making one of the present practical units (say the ampere or ohm) a fundamental magnitude. If we retain the present units of time, energy, and current (or resistance), the units of e.m.f., resistance (or current), capacity, and inductance will remain unchanged; and we are free to vary our units of length and mass, so long as the corresponding unit of energy remains unchanged. We can therefore take the metre and kilogramme instead of the centimetre and gramme; and the Giorgi system is a "rationalised" M.-Kg.-S. system, which is neither electrostatic nor electromagnetic, since neither the electric nor the magnetic constant of free ether is assumed as a fundamental unit, and in which, further, all electric and magnetic formulæ are identical. The data are: (1) Metre, kilogramme, second; whence the watt, joule, &c.; for kg. $\times$ m.$^2$/sec.$^2 =$ 10,000,000 grm.-cm.$^2$/sec.$^2 = 1$ joule; (2) ohm, as a fundamental unit; (3) ohm, mho, coulomb, volt, farad, henry, and ampere, as before; (4) unit of m.m.f., the ampere, already practically used under the name of ampere-turn; unit of magnetic flux = volt-sec. (= weber); and magnetic inductance (permeance), the henry; (5) unit of magnetic force (magnetic field-intensity, gradient of magnetic potential), the ampere/metre (or if desirable amp./mm, or amp./inch); that of electric force (electric field intensity or gradient of electric potential), the volt/metre; magnetic induction (magnetic displacement, magnetic influx per unit area), the weber/metre$^2$; electric induction (displacement, flux per unit area), the coulomb/metre$^2$; magnetic inductivity (permeability, magnetic constant of a medium), the henry/metre [the magnetic constant of free ether being $\mu_0 = 0{\cdot}000{,}001{,}256$ henry/m.]; electric inductivity (dielectric power, electrostatic constant, ratio of electric displacement to electric force), the farad/metre [the electric constant of free ether being $88{\cdot}42 \times 10^{13}$ farad/m.]; electric conductivity, the mho/m. As an illustration, find the capacity of the earth (radius $= 6 \times 10^8$ cm.) in farads: (1) Ordinary

method, $C = r/k = 6 \times 10^8/1$ c.g.s.e.-s. units, $= 6 \times 10^8 \div v^2$ or $6 \times 10^8 \div (9 \times 10^{20})$ c.g.s.e.-m. units, $= 6 \times 10^8 \div (9 \times 10^{20}) \times 10^9$ or $67 \times 10^{-5}$ practical units; (2) Giorgi's system, $r = 6 \times 10^6$ metres, dielectric constant of free ether $= 88 \times 10^{-12}$ farad/metre, capacity of earth $= 4\pi kr = 67 \times 10^{-5}$ farad. A. D.

**793.** *Distance between the Plates of an Influence Machine.* **H. Wommelsdorf.** (Ann. d. Physik, 15. 5. pp. 1019–1025, Dec. 23, 1904.)—In continuance of previous work [see Abstract No. 174 (1905)], the best distance apart of the plates of a machine is investigated. For the particular machine used 4·5 mm. is found to be the best distance. A smaller separation than this causes the machine to excite very quickly and to retain its charge for a considerable time, but the current and voltage in the external circuit are small. For a larger distance the useful energy is greatly diminished and the time of excitation increased. R. S. W.

**794.** *Heat Liberated in Paraffin in a Rotating Electrostatic Field of High Frequency.* **C. E. Guye** and **P. Denso.** (Comptes Rendus, 140. pp. 433–434, Feb. 13, 1905.)—The authors have previously shown how to obtain a rotating electrostatic field [see Abstract No. 2008 (1904)], and in the present note state the result of measuring, by means of an iron-constantan thermo-couple, the heating effect in paraffin of such a field. They find that for constant frequency the heat produced is proportional to the square of the e.m.f. employed; for the same e.m.f. it is proportional to the frequency; and the ratio of power consumed in a rotating field to that for the same frequency alternating field is about 2·56. S. G. S.

## DISCHARGE AND OSCILLATIONS.

**795.** *The Hertz Phenomenon.* **A. Filippini.** (N. Cimento, 8. pp. 264–268, Oct., 1904.)—Various experiments on the modification of the discharge between points and spheres brought about by a third conductor are described. Also the effect of the ultra-violet light from one discharge in facilitating another is observed, but the author failed to find the inverse of this, or the reversal of the Hertz phenomenon; the sparks never produced any observable diminution in the activity of a neighbouring spark. S. G. S.

**796.** *Edison Effect in Air at Atmospheric Pressure.* **W. Mitkiewicz.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. pp. 65–67, 1904.)—The author has already shown that the Edison effect can be observed in hydrogen at atmospheric pressure [see Abstract No. 597 (1904)]. In the present paper he describes how it can be produced in air at atmospheric pressure. A 3 mm. diam. carbon is placed between two thicker 15 mm. carbons forming the arc, and made to glow by the current. A similar thin carbon is placed a few mm. from the other, and can be connected to either of the thick carbons (anode or kathode) through an ammeter. When joined to the anode a current of 150 milliamps. flows as soon as the first thin carbon gets red-hot. In the reverse direction the current does not exceed 0·2 milliamp. and does not increase noticeably when the main current is increased. L. H. W.

**797.** *The Abraham-Lemoine Method of Measuring very Small Intervals of Time; Application to Determination of Direction and Velocity of Discharge in Vacuum Tubes.* **J. James.** (Ann. d. Physik, 15. 5. pp. 954–987, Dec. 23,

1904. Extract of Erlanger Dissertation.)—The paper is in two parts: the first is a detailed account of the experiment of Abraham and Lemoine in which the Kerr phenomenon of double refraction in carbon bisulphide produced by a transverse electric field is employed for the determination of intervals of time of the order of $10^{-9}$ second [see Abstract No. 857 (1900)]; the second is a description of an attempt to measure the velocity and direction of propagation of the discharge in a vacuum tube by employing the results given in the first part. I. The method is discussed mathematically with the object of determining (i.) the relation between the double refraction in the carbon bisulphide and the angle through which the analysing nicol must be rotated to render the two images obtained on account of the double refraction, of equal intensity; (ii.) the relation between the charge on the condenser plates and time; (iii.) the relation between $\phi$, the double refraction, and time. In (i.) it is shown that the rotation, $\alpha$, undergone by the analysing nicol is equal to the retardation of one component of the ray behind the other which takes place in the carbon bisulphide between the plates of the condenser, and due to the double refraction caused by the electrical field. Even in the case in which the spark employed as source of illumination has variable intensity, $\alpha$ measures the mean value of $\phi$. The relation (ii.) is obtained in the ordinary way from Kelvin's equation for the discharge of a condenser. In (iii.) it is assumed that the Kerr effect ($\phi$) is instantaneous, and is proportional to the square of the p.d. between the plates of the condenser [see Abstract No. 529 (1905)]. A curve for variation of $\phi$ with time is deduced, and it is found to present maxima and minima similar to those of the curve for the discharge of the condenser, with the difference that the harmonic term contains the square of a cosine instead of the first power, and the curve, therefore, lies entirely on the positive side of the time axis. Then follow experiments, undertaken with the object of verifying these results. The light from the spark is made to travel over a longer and longer path before passing through the carbon-bisulphide condenser, the amount of double refraction in each case being measured. On calculating the time required to traverse each path, from a knowledge of the velocity of light, it can be found how the double refraction decreases with time. There is a very close agreement between the observed and the calculated rate of fall, showing the extreme likelihood of the Kerr effect being instantaneous. The greatest length of path over which the light travels is 690 cm. Longer paths were tried, but the maxima corresponding to the oscillations in the charge on the condenser could not be observed, probably owing to the rapid damping of the vibration. The curve differs slightly in shape from that obtained by Abraham and Lemoine. The effect of a second condenser in parallel was observed, and also the effect of varying the resistance and inductance of the discharge circuit. II. Using different parts of the vacuum tube as source of illumination in place of the spark as employed in Part I., values of $\phi$ would be obtained, which correspond to greater time intervals when parts of the tube in which the discharge occurs at a later time are employed than when those parts of the tube are used at which the discharge occurs earlier, and the retardation in time could be calculated from the equivalent length of path of light required to give the same retardation when the original spark is employed. Many experiments were performed, and several forms of tube were used, but no such retardation as that expected could be observed. S. G. S.

798. *Anode Glow.* **E. Gehrcke.** (Deutsch. Phys. Gesell., Verh. 7. 3. pp. 63-70, Feb. 15, 1905. Physikal-Techn. Reichsanstalt, Charlottenburg,

Dec., 1904.)—The negative glow is supposed to be due to the ions set free by collisions of neutral atoms with the electrons coming from the Crookes space. Such a glow may be expected wherever the field is intense enough to cause ionisation by collision, *i.e.*, where the potential gradient is large. Skinner has shown that there is a sudden fall in potential near the anode, and therefore a glow analogous to the negative glow may be looked for. At suitable pressures the author has demonstrated the presence of this glow, and has shown that the extent of the anode covered by it is proportional to the voltage. Oxidised nickel electrodes are found to be the most suitable for the purpose. R. S. W.

799. *Kathode Rays Emitted by the Anode.* **E. Rogovsky.** (Comptes Rendus, 140. pp. 575–576, Feb. 27, 1905.)—Rays deviable in a magnetic field are emitted from the anode of a Crookes tube with aluminium cross when the tube is actuated by means of a coil giving a 3 to 5 cm. spark if the resistance of the primary is increased nearly to the point of stopping the action of the coil. G. E. A.

800. *Equivalent Spark of Röntgen-ray Tube.* **S. Turchini.** (Comptes Rendus, 140. pp. 649–652, March 6, 1905.)—Using the radio-chronometer of Benoist, if a tube with equivalent spark be used, the degree of exposure is always the same. The determination of the equivalent spark length is therefore important. The author has studied the variations of such equivalent spark length as a function of (1) the current; (2) of the coil used; (3) of the frequency of the interrupter. A stroboscopic arrangement was used for determining this frequency, while a Gaiffe milliamperemeter enabled readings to be taken of the current in the coil secondary. Under (1) the results show that the equivalent spark length increases faster than the current. (2) All other things being equal, the equivalent spark of a tube supplied by a coil of large self-induction is less than when supplied by a coil with small self-induction, the difference increasing as the frequency becomes lower. (3) With 0·5 milliamp. in secondary, for frequencies of 15, 31, 63, 126 per sec., the equivalent spark values were 8, 6·5, 4, and 2·5 cm. respectively. A curve plotted from these results shows that the equivalent spark tends towards a limit as the frequency increases. L. H. W.

801. *Ionisation in Flames.* **P. Massoulier.** (Comptes Rendus, 140. pp. 647–649, March 6, 1905.)—By using electrodes that are vertical and placed symmetrically in the flames, so as to be approximately at the same temperature and under the same conditions, more regular results are obtained, and reversal of the field produces no change in the trend of the phenomena. The currents that pass with a given potential-difference are sensibly independent of the distance between the electrodes, the variations observed being unsystematic and attributable to want of homogeneity in the flame; and the ionisation in flames shows itself to be dependent not only on the temperature, but also on the reactions that occur. With potential-differences of 2 or 4 volts between electrodes 8 or 10 mm. apart, the field is entirely localised in the immediate neighbourhood of the electrodes within layers not more than ½ mm. thick; outside these the ionisation is too small to affect the current. With much higher potential-differences the fall of potential at the anode is relatively small, but that at the kathode enormous, the field in the central region being insignificant, as before. In this central region there are at least $10^{10}$ ions of each sign per c.cm. [See also Abstract No. 606 (1905).] R. E. B.

**802.** *Research on Condenser Sparks, especially as to their Extinction.* **J. Koch.** (Ann. d. Physik, 15. 5. pp. 865–905, Dec. 23, 1904. Phys. Inst. d. Univ., Upsala, Oct., 1904.)—When a condenser has been discharged there remain two charges: (1) *Arrears*, occurring as a polarisation of the dielectric; (2) *Remainder-charge*, some remnant left in the condenser of the original disposable charge. Heydweiller gave an expression connecting the remainder-charge $q_r$, the capacity $c$, and the resistance in the gap $r$, as follows: $q_r^2/4c^2r =$ constant. Heydweiller also found that this constant is equal to the ratio $f/t$, where $f =$ the energy developed in the spark and $t =$ the time of the discharge. The author uses a condenser which is charged by a machine, a spark-gap, a variable resistance, and a self-induction in circuit; and he uses an electrostatic voltmeter and quadrant-electrometer. The distance between discharge-points can be varied by a micrometer reading to 1/200 mm. A long experimental research is given, principally on the remainder-potential ($V_r$). He finds a relation $(V_r - a)^2/4r =$ constant, so that his results do not confirm those of Heydweiller. He considers the latter's formula approximately true only for large circuit resistances. He also gives a much more complex relation for the energy developed, viz., $f = bt + ac\,(V_0 - V_r)$.

P. E. S.

**803.** *Selective Properties of Resonator Gratings.* **C. Schaefer.** (Ann. d. Physik, 16. 1. pp. 106–115, Jan. 26, 1905. Physikal. Inst. d. Univ., Breslau, Nov. 18, 1904.)—Garbasso showed that systems of linear resonators have selective properties towards electric waves whose wave-length is of a magnitude of the same order as the linear dimensions of the resonators. These resonator gratings reflect to a considerable extent those waves whose period corresponds to that of the resonator. Hence, if such a grating is introduced between a sender and a receiver of waves, the receiver shows a marked diminution in the waves received. Aschkinass and the present author showed [see Abstract No. 1925 (1901)] that such gratings, if immersed in media of different permittivities, follow a rule analogous to that which, in the optical case of the visible spectrum, is known as Kundt's rule. Further, Garbasso and Aschkinass showed that a three-dimensional resonator grating can effect the dispersion of electric waves. Recently M. Planck has developed a theory of the dispersion and absorption on the electromagnetic basis, in which is examined the dependence of the absorption on the number of absorbing resonators per unit volume. It is this theory that the present author here puts to the test by experiments. The resonating elements were arranged in various ways, and the results obtained showed departures from Planck's theory, which are possibly attributable to the fact that the experimental arrangements are not the ideal ones contemplated in the hypothesis made in the theory. E. H. B.

**804.** *Theory of Undamped Vibrations.* **S. Maisel.** (Phys. Zeitschr. 6. pp. 38–43, Jan. 15, 1905. Physikal. Inst. d. Univ. St. Petersburg.)—The author criticises the conclusions of Duddell [see Abstract No. 850 (1901)] and Janet [see Abstract No. 1714 (1902)] that the current in the shunt to the singing arc is sinusoidal, and is undamped owing to the arc having a negative resistance during part of the cycle. The paper is a mathematical discussion of a branched circuit of the "Duddell" type, the arc, however, being replaced by a conductor obeying Ohm's law, but which is a non-conductor for p.d. of less than a certain value. On the author's theory the energy lost in the circuit is drawn from the battery, and he claims that this is a more rational explanation of the maintenance of the vibration, than that the energy is drawn from the arc during that part of the oscillation for which *dv/di* is negative. Whether the resistance of the conductor which replaces the arc suddenly becomes infinite on the p.d. falling to the limiting value, or whether a counter e.m.f. is supposed to act in the circuit, is immaterial; in the calculation, the latter alternative has been chosen. The equations for the currents in the main and branch circuits are obtained, and from these the p.d. acting between the ends of the conductor representing the arc is found. When this is less than or equal to the counter-e.m.f. in the conductor, the current ceases; the relation between the constants of the circuits for this to occur is given. The cessation of this current marks the end of the first phase. During the second phase no current flows in the conductor-circuit, and therefore Kelvin's equation applies to the battery and condenser-circuit; the current flows into the condenser, charging it in the original sense. The third phase begins when the current is re-established in the conductor-circuit, and this occurs when the p.d. between its ends reaches some value which is in general greater than that at which the current ceased, but which may, in the limiting case, be equal to it. If, on the discharge of the condenser, the p.d. is not lowered to the critical value, the current in the conductor is not interrupted, and in this case the oscillation is quickly damped out. The author has constructed curves from his equation, and finds that they are in close agreement with those experimentally found for the singing arc. S. G. S.

**805.** *Transparence of Liquids for Electric Waves.* **V. Buscemi.** (N. Cimento, 9. pp. 105–112, Feb., 1905. From Boll. dell' Accad. Goenia, Fasc. 83, 1904.)—The author describes experiments on the transparency of a number of liquids for electric waves. A Fleming quantitative magnetic detector [see Abstract No. 372 (1904)] was used for measuring the strength of the waves received from a transmitter entirely enclosed in an iron case. The lid of this case was made metallically continuous by means of mercury in a rill round the top. The only opening was one 35 × 40 mm., and the waves had to pass through a glass trough which was filled with the liquids examined (6 mm. thickness of liquid). The following table shows the deflection of the galvanometer spot, from which the relative absorptive power of the different liquids for the waves can be inferred :—

| Glass Vessel filled with | Deflection in mm. | Glass Vessel filled with | Deflection in mm. |
|---|---|---|---|
| Air | 21 | Nitric acid (conc.) | 0 |
| Vaseline | 22 | Distilled water | 7 |
| Petroleum | 16 | Sodium chloride solution (to 0·5 per cent.) | 1·5 |
| Benzine | 17 | Sodium chloride solution (over 1 per cent.) | 0 |
| Ether | 12 | Sea-water | 0 |
| Sulphuric acid (conc.) | 0 | | |
| Hydrochloric acid (conc.) | 0 | | |

L. H. W.

**806.** *Resonance in Wireless Telegraph Circuits.* **G. W. Pierce.** (Phys. Rev. 20. pp. 119–120, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904.)—A report of some experiments on the conditions for resonance in wireless telegraph circuits with various lengths of antennæ. The circuits employed were of the electro-magnetically connected type. The receiving instrument is a Fleming type high-frequency dynamometer as before [see Abstract No. 2688B (1904)]. By changing the lengths of the antennæ (between 4 and 24 m.), and using for them from one to eight wires, the receiver was tuned to resonance. In the case of sharpest resonance the energy received fell to half for a change of 2 per cent. in the period of the condenser circuit at the receiver station. E. H. B.

**807.** *Rectification of Electric Oscillations by Means of a Vacuum Valve.* **J. A. Fleming.** (Roy. Soc., Proc. 74. pp. 476–487, March 16, 1905.)—The author finding the aluminium valve cell unable to rectify electric oscillations, has constructed a rectifier based upon the unilateral conductivity shown by the Edison effect. In the best form of construction a metal plate bent into a cylinder and carried by a platinum wire sealed into the lamp bulb, surrounds the entire carbon loop. The filament is preferably a 12-volt one, run at 2·75 or 3 watts per c.p. off accumulators. A galvanometer is placed in the circuit comprised of the metal cylinder, vacuous space and the terminal of the filament connected to the negative pole of the battery, as well as a coil, which may be the secondary of an air-core transformer, in which the oscillations are set up. An arrangement of two such vacuum valves with a differential galvanometer is described, by which more of the oscillation can be converted. Oscillations in open circuits can be detected; this, however, involves the use of an oscillation transformer for raising the voltage (52 turns of No. 22 and 36,000 turns of No. 36 for primary and secondary respectively). Investigation of the unilateral conductivity by means of a galvanometer and an electrodynamometer in series showed that the ratio of the readings of the two instruments (converted to milliamps.) was not constant; the rectification was less complete in proportion as the temperature of the filament increased; the current passed is from 80 to 90 per cent. continuous, and from experiments it is thought that 100 per cent. (complete rectification) could be reached if the metal cylinder were water-cooled. The vacuous space has a maximum conductivity corresponding to a p.d. of about 20 volts for the valve used; the current is to a large extent independent of the e.m.f. creating it, and at no stage proportional to it, so that the device is not strictly metrical. It is also stated to be less sensitive than a coherer or magnetic detector. L. H. W.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**808.** *Selenium and its Electrotechnical Importance; Light-telephony.* **E. Ruhmer.** (Elektrotechn. Zeitschr. 25. pp. 1021–1030, Dec. 1, 1904. Paper read before the Elektrotechn. Verein, March 22, 1904.)—After a very full account of the earlier researches on the properties of selenium, with references to the original papers, the author deals with the practical utilisation of selenium for making selenium cells. For "soft" cells, which are those mostly used, the relation between illumination and resistance is approximately expressed by $W_a/W_b = (b/a)^n$, where $a$ is the less and $b$ the more intense illumination, and $W_a$, $W_b$ the respective resistances. The exponent $n$, according to the author, varies between 0·25 and 0·35 (in a specially good cell $n = 0·4$). Typical curves are given showing the behaviour of cells as regards intensity of illumination and time (recovery). An experiment is also described showing that a cell will respond to light which has passed through an apparently non-transparent sheet of ebonite, giving a method of obtaining the refractive index and hence the dielectric constant (fairly concordant values). Numerous applications are then described, including the use as a Rontgen-photometer, besides a number of other uses which have been previously described. [See also Abstract No. 99 (1903).] L. H. W.

**809.** *Resistance Measurements in Platinum Thermometry.* **H. Edwards.** (Amer. Acad., Proc. 40. 14. pp. 549–555, Jan., 1905.)—Describes difficulties met with in accurate platinum thermometry due to variations in the lead resistances, and—in cases where low-resistance leads are used—to the heat-conductivity of the leads. A method of resistance measurement is described, which is designed to overcome these difficulties by greatly reducing the accuracy with which it is required to know the lead resistances. For this purpose the galvanometer of a bridge system is connected first to one and then to the other end of the resistance under measurement (*i.e.*, the platinum thermometer), and the change in the balance position found on a bridge wire. This difference can be made conveniently small by suitably adjusting the other arm of the bridge. This method reduces the error arising from uncertainties as to lead resistances to 1/400th of its value in the ordinary method. The arrangement is illustrated by means of diagrams, and the experimental disposition of the bridge is described in detail. W. Ros.

810. *Conductivity of Dielectrics by Means of Ionised Gases.* **C. Nordmann.** (Comptes Rendus, 140. pp. 38–39, Jan. 2, 1905.)—One of the faces of the dielectric sheet is earthed by means of a metal plate, the other face is separated from a second metal sheet by a layer of air. This air is ionised by a radio-active substance, and a voltage applied to the plates large enough to produce the saturation current between them. The potential, E, of one of the faces of the dielectric is measured by an electrometer, and the quantity of electricity, Q, supplied to it per second is found by similar means. It is then shown that, under certain conditions, $R = E/Q$. The results attained by this method are to be given later. R. S. W.

811. *Measurement of Electrostatic Capacities.* **I. Revilliod.** (Schweiz. Elektrot. Zeit. 2. pp. 3–4, Jan. 7; and pp. 23–24, Jan. 14, 1905.)—A magnet is suspended in the interior of a coil, the axis of the coil lying in a horizontal plane and normal to the magnetic meridian. To the ends of the coil a condenser is attached. When the magnet is set swinging, an alternating e.m.f. is induced in the coil, and the condenser is charged and discharged. The restoring force acting on the magnet is therefore in part due to the magnetism of the earth, and in part due to currents circulating in the coil. The magnitude of these currents depends on the capacity of the condenser. By determining the time of swing and the logarithmic decrement the electrostatic capacity can be determined. F. E. S.

812. *Sensitiveness of Galvanometers.* **M. Iklé.** (Phys. Zeitschr. 6. pp. 43–44, Jan. 15, 1905.)—The writer calls attention to the fact that the most rational mode of expressing the sensitiveness of a galvanometer is not usually employed, and he recommends the general adoption of the method suggested by du Bois and Rubens [see Abstract No. 1476 (1900)]. According to these authors the sensitiveness should be defined as follows; (1) The current sensitiveness is the permanent deflection in scale divisions per micro-ampere, with scale distance of 1,000 scale divisions, and a periodic time of 10 sec. per complete vibration; (2) the ballistic sensitiveness is the throw per micro-coulomb, with a scale distance of 1,000 scale divisions and a period of 10 sec. The effect of resistance of windings is eliminated by employing a normal sensitiveness $\mathfrak{S}$, for a galvanometer of 1 ohm resistance, defined by the equation $\mathfrak{S} = S/\sqrt{R}$, where S is the sensitiveness as given above. S. G. S.

813. ***Universally Applicable Differential Method of Measuring Low Resistances.*** **H. Hausrath.** (Ann. d. Physik, 16. 1. pp. 134–147, Jan. 26, 1905.)—

The Kohlrausch method of comparing low resistances is modified; a standard wire with sliding contact is used as a comparison resistance, a shunt being placed externally to the points at which the branches leading to the galvanometer arise. The standard wire is doubled, and the sliding contacts leading to the galvanometer are rigidly connected, so that the resistances of the end pieces of the wire, external to the galvanometer contacts, are always equal. It is shown that when this condition is fulfilled, the two halves of the galvanometer being similar, and zero deflection obtained, the unknown resistance bears a constant ratio to that part of the standard wire which is included between the galvanometer contacts. The ratio depends only on the resistances of the standard wire and shunt. The limits of accuracy of the method are discussed, and it is shown that most of the errors are eliminated by exchanging the relative positions of the battery and the conductor joining the unknown and the standard resistances. Applications to the standardising of shunts and resistance boxes are described. S. G. S.

**814.** *Theory of Thermo-electromotive Force.* **C. B. Thwing.** (Phys. Rev. 20. pp. 124–125, Feb., 1905. Abstract of paper read before the Amer. Physical Soc., Dec. 30, 1904.)—Applying J. Traube's application of van der Waals' equation to the calculation of the internal pressure of metals from successive values of their coefficients of expansions [see Abstract No. 2637 (1904)], and comparing these with the known increase in volume, the potential $V = p \,.\, dv/dt$ is found for two temperatures. The differences in the values of $dv/dt$ for two metals are proportional to the thermo-electromotive potential differences. [See also Abstract No. 415 (1905).] S. G. S.

**815.** *Self-inductance Measurements.* **J. B. Whitehead** and **H. D. Hill.** (Amer. Journ. Sci. 19. pp. 149–164, Feb., 1905.)—The best known method of measuring self-inductance is the Rayleigh method, but, when employed, very intelligent and careful work is necessary in order to obtain results concordant to 1 per cent. What seem to be the most accurate methods are various modifications of the Wheatstone bridge using alternating currents, with an electrodynamometer, telephone, or optical telephone, as the measuring instrument. Chiefly of this type are the 26 methods described by Rowland [see Abstract No. 144 (1898)]. The systematic testing of these methods is the aim of the present investigation. With the exception of the methods numbered by Rowland 14, 3, and 25, the Rowland methods are of little value, their chief defect being a lack of sensibility. Method 14, devised and first used by Oberbeck (Wied. Ann. 17. p. 816, 1882), is undoubtedly the best method that we have for the absolute measurement of self-inductance in terms of resistance. It is easy to apply, and the results should not differ by more than 0·2 per cent. Method 25 is better than the Rayleigh method as ordinarily used, is very easy to work, and has a simple formula involving little calculation. Its accuracy is probably limited to about 1 per cent. Method 3 is one for comparing self-inductance with capacity. It is very sensitive, and was found to be very satisfactory. F. E. S.

**816.** *Radio-active Measurements by a Constant Deflection Method.* **H. L. Bronson.** (Amer. Journ. Sci. 19. pp. 185–187, Feb., 1905.)—The usual method of using an electrometer for comparing ionisation currents through gases is to take the rate of movement of the needle. For this to be accurate the following conditions must be fulfilled: (1) The capacity of the system must remain constant. (2) The deflection must be proportional to the potential of the quadrants. (3) The lag of the needle behind the potential must be the same for different rates. Another method proposed is as follows: One pair of quadrants is earthed and the other pair is connected to the testing vessel and to earth through a high resistance. The current in the testing vessel then charges the quadrants until the discharge through the high resistance is equal to the ionisation current. In this case the current is proportional to the potential of the quadrants, *i.e.*, to the deflection of the needle. Liquid resistances have been found unsatisfactory; an ionised gas is found to answer the purpose. Very satisfactory measurements are shown for the decay of thorium emanation, the time taken to reach half value being 54 seconds. **R. S. W.**

**817.** *Sensitive Quadrant Electrometers.* **J. C. McLennan.** (Elect. World and Engineer, 45. pp. 252–253, Feb. 4, 1905. Paper read before the Amer. Assoc. for Advancement of Science.)—In making measurements upon the conductivity of a gas by means of a highly sensitive electrometer such as the Dolezalek type of instrument, considerable delay and inconvenience was frequently experienced on account of the disturbance imparted to the needle by simply breaking the earth connection to the free quadrants. Even comparatively small oscillations imparted to the needle in this way require from ½ min. to 3 or 4 min. to subside, and this period, though not long, is still often quite sufficient to prevent observations under specially interesting circumstances. These disturbances are in great measure due to electrostatic effects caused by the approach of the observer's body, or even of his hand, in the process of breaking the earth connection; and in order to avoid them, it has become the practice to surround the electrometer and the testing apparatus with earth-connected metallic screens, and also to make and break the earth connection to the quadrant by keys of a special form. In using different keys, however, it was found that with electrometers of high sensitiveness, small, though relatively important, initial disturbances still existed, and arose from a variation in the capacity of the measuring system caused by the action of the key itself when the earth connection was broken. In order to overcome this defect a special key was constructed which reduced the variation in capacity to a minimum. The key consists essentially of two brass rod-like portions with a common axis, and with parallel faces as close together as possible without touching. Both parts are pierced by a small opening less than 1 mm. diam., and the earth connection to the quadrants is made or broken by inserting or withdrawing a fine rigid steel wire which moves freely through the opening. With this device the earth connections can be broken with practically no variation in the capacity of the measuring system.

**F. E. S.**

**818.** *Action of Radium Bromide on the Electrical Resistance of Metals.* **B. Sabat.** (Comptes Rendus, 140. pp. 644–646, March 6, 1905.)—The action of the radium radiations upon copper, iron, steel, platinum, brass, German silver, and bismuth was studied. The resistances were measured by a Wheatstone-Kirchhoff bridge and a mirror galvanometer; the radium (0·2 gm. of radium bromide of the highest activity from Curie's laboratory) in a small glass tube was placed inside a paper tube on which the wire under examination was wound. In the experiments of longer duration it was impossible to avoid heat being communicated from the radium to the wire, but this could at the most (from experiments) amount to 0·3–0·4° C. The results are given in full for one series of experiments, in which for wires of iron, platinum, and German silver (all of 0·1 mm. diam.) an *increase* of resistance was observed immediately on being exposed to the radiation; 5 min. after exposure the increases of resistance per cent. were 0·776, 0·257, and 0·092 respectively (and 0·284 for bismuth), equivalent to an increase of temperature of 1·62°, 0·71°, 2·56°, and 0·8° C. respectively. From a consideration of a large number of such experiments the author concludes that a certain amount of increase of resistance takes place immediately on exposure, before any heat interchange could have taken place; the increase also in some cases is greater than that due to communicated heat could possibly amount to. Metals, therefore, absorb Becquerel rays, and principally the $\beta$-rays, transforming a part of the energy of this radiation into calorific energy, raising the temperature of the metals and increasing their resistance. L. H. W.

819. *Hot-wire Instrument with Mirror and Scale.* **K. E. F. Schmidt.** (Zeitschr. Instrumentenk. 25. pp. 10–14, Jan., 1905.)—For the purpose of measuring alternating currents of high frequency the author has found that a hot-wire instrument of the Hartmann and Braun type has great advantages, because such an instrument, since it has inappreciable self-induction and capacity, can be accurately calibrated by continuous currents. The instrument described has the usual sagging wire, but the spindle which ordinarily carries the pointer is provided with a mirror, which is used in conjunction with a telescope and scale. The base plate of the instrument is made of glass, in order to better insulate the terminals of the wire. Tables are given describing tests as to the sensibility and constancy of its action, which show that the greatest error between the extreme indications for any given current are considerably less than 0·5 per cent. J. D. C.

820. *New Form of Ion-aspiration Apparatus.* **H. Ebert.** (Deutsch. Phys. Gesell., Verh. 7. 2. pp. 34–37, Jan. 30, 1905. Physik. Inst. d. techn. Hochschule, München.)—The apparatus is made by Günther-Tegetmeyer, of Brunswick, for the absolute measurement of the ionic charges of the atmosphere, and can, on Mache's principle [see Abstract No. 3274 (1904)], be used for determining the velocity of the ions and the currents. The shortened earthed metallic tube, 3 cm. in diam., is placed vertically, and the aspiration wheel, driven by a spring, by the side of it; the charged rod in the tube has a length of 14 cm. The capacity of the system, cylindrical condenser and electroscope, is only 8 cm., and the time needed for an observation reduced. An auxiliary cylindrical condenser can be fixed to the top of the tube.

H. B.

821. *Automatic Recorder of Amount of Ionisation of the Atmosphere.* **P. Langevin and M. Moulin.** (Comptes Rendus, 140. pp. 305–307, Jan. 30, 1905.)—The air is driven between the plates of a cylindrical condenser, and when a given volume has passed, the anemometer or recorder actuates an arrangement for connecting the inner plate of the condenser to an electrometer. During this first period the plate has been connected to one pole of a battery, and has therefore collected the ions of one kind, and hence a charge of the same sign as the ions has accumulated upon it. The electrometer now exhibits a deflection which is proportional to the charge collected. The mechanism then earths the electrometer and connects the other pole of the battery to the inner plate of the condenser; thus a charge of the opposite

sign is collected during the second period. This is then measured as before, and the process is continued indefinitely. The deflections are recorded on a moving sheet of sensitised paper by a beam of light reflected from the mirror of the electrometer. In order to collect the ordinary or rapidly moving ions, a small capacity of condenser and a strong current of air are necessary, while to collect all the ions a feeble current and a large capacity are employed. The authors are designing an apparatus in which the earthing of the quadrants is avoided, and in which the deviation is constantly proportional to the number of ions of one sign present in the air.

S. G. S.

822. *Recorder of Atmospheric Ionisation by Employing a Jet of Water.* **C. Nordmann.** (Comptes Rendus, 140. pp. 430–433, Feb. 13, 1905.)—An instrument, devised by the author, for the continuous registration of the ionisation of the atmosphere, has previously been described, in which the charge which accumulates on one plate of a condenser leaks to earth through a high resistance. [See Abstract No. 2267 (1904).] When equilibrium is reached, the p.d. which is indicated by the electrometer is proportional to the degree of ionisation of the air and to the value of the high resistance. Hence, to keep the latter constant, a delicate thermostat must be used. In the present paper the author describes how the high resistance may be dispensed with and a water-dropper used in its place. The charge is carried to earth by the drops of water falling from a vessel which is in electrical communication with the plate of the condenser that is collecting the ions. Equilibrium occurs when $V = Q/nr$, where V is the potential of the collecting conductor, Q is the charge collected per sec., $r$ the radius of the drops of water, and $n$ the number of drops falling per sec. The deflection of the electrometer is photographed on a revolving drum.

S. G. S.

823. *Kathode Glow Oscillograph.* **E. Gehrcke.** (Zeitschr. Instrumentenk. 25. pp. 33–37, Feb., 1905. Communication from the Physikal.-Techn. Reichsanstalt.)—The author has recently pointed out that the property noticed by Hehl [see Abstract No. 563 (1903)], that the "negative glow" occupies an area which is proportional to the current, can be used for examining alternating-current waves. An oscillograph has been made, and is here described; this is practically the same as that made by Ruhmer [see Abstract No. 394B (1905)]. The nickel electrodes must be clean and bright, and the best results are obtained with a vacuum corresponding to 7 or 8 mm. Hg. Numerous oscillograms are given which clearly show the capacity of the instrument and its drawbacks, the chief of which is that the "glow" disappears below about 300 volts, so there is a gap at points where the potential falls below this value. It is suggested that the law of Hehl may not hold in the region of the gaps. [See also Abstract No. 798 (1905).] L. H. W.

824. *Instrument for Measurement of Long Electric Waves, and also Small Inductances and Capacities.* **J. A. Fleming.** (Roy. Soc., Proc. 74. pp. 488–498, March 16, 1905.)—The author describes a new closed circuit wave-length meter in which both the capacity and the inductance are adjustable. The chief object was to construct an instrument which with a fairly large inductance of its own should be capable of being associated with the circuit to be tested, and set in action by it, by means of the least

mutual inductance possible. Two forms are described, the simpler consisting of a long ebonite tube (1 m. long, 10 cm. diam.) on which an inductance coil of 100–200 turns of No. 14 wire are wound. The capacity consists of an outer brass tube, to which one end of the inductance wire is fixed, and a fixed brass tube inside the ebonite tube. The latter slides on, and is supported on, the inner brass tube at one end and in a curved metal collar at the other end, these two points being joined by a copper bar. Resonance is indicated by a neon vacuum tube fastened to the outer brass jacket. Inductances are readily measured by the aid of this instrument ; in the case of an inductance of a few hundred cm., as follows : An insulated wire is laid alongside the copper bar and the circuit completed by a condenser of known capacity C and a spark-gap. Oscillations are then set up and the handle of the instrument shifted until the neon tube glows. The oscillation constant (O) of the wavemeter is read off on a scale. If L is the inductance of the wire of the circuit, $O = \sqrt{CL}$. Increasing now the inductance, by adding the wire to be measured (L′), the handle is again set, from which O′ the new oscillation constant is found. Then $O' = \sqrt{C(L + L')}$. Hence $L' = (O'^2 - O^2)/C$. The oscillation constant of such wavemeters is determined directly by means of the author's standard of wave-length [see Abstract No. 2683 (1904)], the method of so doing being described. The instrument can have its scale marked to show (1) oscillation constants, (2) frequencies, or (3) wave-lengths, in feet or metres, and it is shown that it can also be used for determining the coefficients of coupling and the mutual inductances of oscillation transformers, examples being given. L. H. W.

## ALTERNATING CURRENTS AND MAGNETISM.

825. *Analysis of Alternating Currents.* **G. E. Leithäuser.** (Deutsch. Phys. Gesell., Verh. 7. 4. pp. 72–74, Feb. 28, 1905. Phys. Inst. d. Univ., Berlin, Feb. 6, 1905.)—The stroboscopic disc method is employed, but instead of illuminating the disc by means of an arc or incandescent lamp carrying the current to be analysed, a König's capsule is used. The gas which is used as illuminant passes through the capsule on its way to the jet. One wall of the capsule is an elastic membrane which carries a thin iron sheet. This sheet is situated very close to the pole of an electromagnet, the winding of which is placed as a shunt across a non-inductive resistance through which the current under examination passes. Thus the current in the electromagnet, and hence the movements of the diaphragm and the flame, are periodic, and the harmonics present can be detected by means of the stroboscopic disc. S. G. S.

826. *Magnetisation Numbers of some Organic Compounds and Notes on Independence of feebly Magnetic Liquids on Dissociation and Strength of Field.* **S. Meyer.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2a. pp. 1007–1017, July, 1904. From the Inst. für theoret. Physik an der k.k. Univ. in Wien.)—We owe the greater part of the determinations of magnetisation numbers to S. Henrichsen, who obtained as a chief result that, for organic compounds, the molecular magnetisation number can be calculated additively from the values for the component atoms. This generalisation would lose much of its value if Freitag and Heinrich's statements that the magnetic susceptibility is dependent on field strength were found to be correct ; the author therefore records

details of his experiments to confirm the older view due to Henrichsen. The experiments were made by the method of the iron-free balance. A long thin glass tube was attached to one beam of the balance, and the tube (which contained the experimental liquid) was so placed as to hang in the middle of a uniform magnetic field of strength about 18,000 c.g.s. Homologous series of compounds were chiefly investigated, viz., the methyl alcohol series; four paraffins (pentane, hexane, heptane, and octane); four aromatic hydrocarbons (benzene and its immediate homologues); certain amines (aniline, toluidine, dimethyl aniline, diethyl aniline); ethyl bromide and iodide; chlor-, brom-, and iod-benzene; safrol and isosafrol; methyl eugenol and isoeugenol. The isomeric substances in this list show, at least to a first approximation, no difference in magnetisation numbers, and the results of the work in general confirm Henrichsen's conclusions. The opportunity was taken to make an independent investigation of the non-dependence of the magnetisation number of a substance on its dissociation in solutions; the results, of which details are given for solutions of cobalt chloride and copper sulphate, confirm the work of other investigators. D. H. J.

827. *On what Remains Constant in a Permanent Magnet.* **R. H. Weber.** (Ann. d. Physik, 16. 1. pp. 178–187, Jan. 26, 1905. Phys. Inst., Heidelberg, Dec., 1904.)—A semicircular magnet is used in conjunction with two quarter circular pole-pieces, the whole forming a ring of 14 cm. axial length, the diameter of the material being 3 cm. There is a constant gap between the upper faces of the pole-pieces of 2 mm. The pole-pieces can be moved together so as to put a gap between their lower faces and the faces of the semicircular magnet. The whole magnetic circuit was wound with a single layer of wire. Measurements are made of the induction as the gap between magnet and pole-pieces is altered. The experimental values agree closely with those calculated from simple theory, especially as gap increases. In the gap were placed either plates of inert substance or iron plates. The general results are: (1) If field-changes of not more than 15 per cent. and changes in magnetic resistance are made, the magneto-motive force remains practically constant. (2) For greater field alteration the same is probably true, but is not definitely proved. (3) Hysteresis is not shown when the gaps are large. (4) There is no constancy of the outer lines of force in an unsaturated magnet. P. E. S.

828. *Galvanomagnetic and Thermomagnetic Effects of Various Metals.* **H. Zahn.** (Ann. d. Physik, 16. 1. pp. 148–154, Jan. 26, 1905. Phys. Inst. der Univ., Giessen, Nov., 1904.)—In a former paper [see Abstract No. 3263 (1904)] the author has determined the transversal effect on bismuth, antimony, selenium, iron, nickel, and cobalt. A further series of experiments has been carried on with the metals iridium, palladium, platinum, copper, silver, zinc, and the alloys brass, German silver, and steel. For most of the metals the Hall effect was known, and it was a question of measuring the thermomagnetic effects, consequently the plates were made somewhat thicker than usual. The author finds that the sign rule for R and S still holds, but it is astonishing to note that for iridium the sign rule is different from two other metals of the platinum group; this is analogous to the case of nickel, which has a sign rule different from that of copper and iron. A table is given showing the values of Q, R, and S for the different metals; the quantity P was only measured in the case of steel. The approximate correction factor $\psi$ for the temperature effect was also determined, and in the case of the thinner

iridium and palladium plates the value was thereby increased by 8 per cent.; for the thicker plates the increase was 2 per cent.; for zinc 1 per cent., while for copper and silver the correction was negligible. E. S. A. R.

829. *Conditions for Maximum Effect in the Marconi Detector.* **F. Piola.** (Elettricista, Rome, 4. pp. 51–54, Feb. 15, 1905.)—In a previous paper the author has shown that the effect of a rapidly oscillating magnetic field upon a piece of iron which is being subjected to an alternating field of relatively long period is to produce an apparent increase in the permeability, and that the greater the damping of the rapidly oscillating field the greater is the effect [see Abstract No. 2977 (1904)]. He has now continued his investigations with the object of finding the best conditions for producing an effect in a telephone circuit which includes a coil wound upon the piece of iron, and by means of which the sudden alteration in magnetic induction due to the incidence of the electric waves is detected. In all, six points are investigated and the results are as follows: (1) With a rapidly damped oscillation the effect is greatest when the phase of the first half period of the superimposed field coincides in sense with that of the primary field, and is least when the two are in opposite senses. (2) The effect is greatest when the superimposed oscillation occurs at the steepest point of the primary cycle, *i.e.*, at a point of inflection, or at the instant when $dI/dH$ is a maximum. (3) The primary field should comprise as large a cycle as possible; *i.e.*, the iron should as nearly as possible reach saturation at each end of the cycle. (4) The iron should be "aged" for a long time, and should be finely subdivided. (5) It should be arranged in a closed magnetic circuit, to avoid demagnetising effect. (6) In this section the relation between resistance of secondary winding and that of telephone, and the size of wire and dimensions of coils, are discussed. S. G. S.

830. *Coefficient of Magnetisation of Bismuth, &c.* **G. Meslin.** (Comptes Rendus, 140. pp. 499–502, Feb. 20, 1905.)—In this note the author gives the results of his experiments on the determination of the coefficient of magnetisation and magnetic susceptibility of bismuth, mercury, potassium sulphate, and potassium nitrate. For mercury the result $-0{\cdot}185 \times 10^{-6}$ agrees very well with that of Plücker (0·182). The results of Quincke, which are given in terms of the magnetic susceptibility referred to that of water, are first divided by the density of mercury and then multiplied by the coefficient of magnetisation of water, to bring them to c.g.s. units. The value so obtained ($-0{\cdot}188 \times 10^{-6}$) is in close agreement with the author's. The value of the coefficient of magnetisation for bismuth is $-1{\cdot}47 \times 10^{-6}$, which is higher than that found by Curie (1·35), and below those found by Becquerel (1·75) and by Faraday (1·64). That of Ettinghausen is 1·44. The value for potassium sulphate is found to be $-0{\cdot}42 \times 10^{-6}$, and for potassium nitrate $-0{\cdot}32 \times 10^{-6}$ (Curie, 0·43 and 0·33 respectively). S. G. S.

831. *Falmouth Magnetograms from* 1891–1902. **C. Chree.** (Roy. Soc., Proc. 74. pp. 323–326, Jan. 23, 1905. Abstract. From the National Physical Laboratory.)—The paper contains an analysis and discussion of the results obtained from the declination and horizontal force magnetograms at Falmouth on quiet days from 1891, when the records commenced, until 1902, comparisons being instituted in many cases between Kew and Falmouth results. The total secular changes of declination from 1891–1900 at Kew and Falmouth

were identical, and the changes from year to year were closely alike. In horizontal force the annual changes recorded at the two stations did not agree so closely, and on the average the change at Falmouth was somewhat the greater. Though differences certainly exist between the phenomena at Kew and Falmouth, the points of agreement found when discussing the "non-cyclic effect" in the diurnal variation of the declination give strong support to the view that the phenomena are not accidental, but are probably due to a true physical origin. The data considered being the means from the five selected quiet days a month, out of the 120 months under consideration there is agreement of sign in the non-cyclic effects at Kew and Falmouth in 69 cases, and disagreement in only 22, the effect being nil at one or both stations in the remaining 29 cases. Moreover, at both places the *sign* of the non-cyclic effect, though prevailing positive throughout the year, is distinctively negative near midsummer, and the seasonal variations in the two cases are fairly alike. In horizontal force the non-cyclic effects at Kew and Falmouth are large and closely alike. From 1891–1900 there were only 5 months in which these effects differed in sign, as against 99 in which they agreed. While the mean daily range of temperature at Falmouth is notably less than at Kew, the daily ranges of declination at the two places are as nearly as possible equal, and the daily range of horizontal force is somewhat larger at Falmouth. Various comparisons are instituted between the variations of the daily ranges and the spotted area of the sun, the latter being utilised from the values of whole spots, umbræ or faculæ from the Greenwich observations, and from Wolfer's sun-spot frequencies. The results indicate that the differences between observed magnetic ranges at individual stations, and those calculated from any of the above measures of solar disturbance, though small, cannot be regarded as wholly accidental. C. P. B.

## ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

**832.** *Lévy-Dorn Orthodiagraph.* (Archives d'Él. Medicale, 12. pp. 931–934, Dec. 25, 1904.)—The instrument consists firstly of a firm pedestal, at the upper extremity of which is a socket through which a sliding rod passes. This rod supports at one end the movable portion of the apparatus, which is counterpoised by a weight at the other end. By means of joints between the pedestal and the socket the rod can be placed in any position and fixed in that position by means of screws. The movable portion contains a rectangular frame which carries the tube and the fluorescent screen, and these are arranged in such a way that the normal ray from the tube always falls on the centre of the screen. A pencil fixed above the latter materialises this ray. The attachment of this frame is such that two movements are permitted: firstly, rotation about an axis at right angles to the rod; and secondly, by means of a sliding joint, to and fro movement, in the same plane. By means of these two movements the normal ray can be made to pass through any point of a foreign body interposed between the tube and the screen, and by causing this ray to pass through the different points of the contour of a foreign body in turn, an exact drawing of it can be obtained, either on the skin of the part of the body containing it, or on a paper screen which is fixed to the apparatus for this purpose. H. W. P. Y.

## REFERENCES.

833. *Specific Velocity of the Ions in the Atmosphere.* **H. Mache** and **E. v. Schweidler.** (Phys. Zeitschr. 6. pp. 71–73, Feb. 1, 1905. II Physik. Instit. d. Univ., Wien.)—Referring to their method [see Abstract No. 3274 (1904)], the authors describe measurements made at Seewalchen, on the Attersee, in Upper Austria, with a Günther-Tegetmeyer apparatus, similar to that mentioned by Ebert [see Abstract No. 820 (1905)]. H. B.

834. *New Theory of Electrical Influence Machines.* **V. Schaffers.** (Annal. Soc. Sci. de Bruxelles, 29. pp. 1–86, 1904–1905.)—A much fuller account of the author's investigations [see Abstract No. 1170 (1904)], with comparisons of the output of different types of machines.

835. *Kathode Rays.* **K. Baumgart.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 9. Sec. II. of Physical Part, pp. 93–124, 1904.)—The concluding part of a clear, illustrated, critico-historical account of kathode rays. D. H. J.

836. *Ionisation Produced by Ozone.* **F. Richarz.** (Phys. Zeitschr. 6. pp. 1–2, Jan. 1, 1905. Phys. Inst., Marburg, Nov., 1904.)—Remarks on the paper by Graetz [see Abstract No. 532 (1905)] and the discussion upon it. The writer describes the results obtained by various observers on the action of ozone and the production of ions by it. Graetz was unable to find any photographic action due to ozone. J. J. S.

837. *Kathode Fall from Hot Carbon.* **J. A. Cunningham.** (Phil. Mag. 9. pp. 193–207, Feb., 1905.)—A continuation of the experiments described in Abstract No. 822 (1903). Curves are given showing the sudden decrease in the kathode fall when a certain temperature is reached. R. S. W.

838. *Control Apparatus for Thermo-elements.* **F. W. Adler.** (Ann. d. Physik, 15. 5. pp. 1026–1032, Dec. 23, 1904. Phys. Inst. d. Univ., Zürich, Oct., 1904.)—The junction which is to be kept at a steady temperature is placed in a U-tube, which, in turn, passes through a bulb containing mercury. Into the stem of the mercury bulb are fused two wires, and the circuit is so arranged that when the temperature varies the galvanometer is short-circuited. R. S. W.

839. *Construction of Electroscopes.* **O. W. Richardson.** (Nature, 71. pp. 274–276, Jan. 19, 1905.)—A description is given of the various electroscopes that have been evolved in recent years for research on radio-active substances. R. S. W.

840. *The Electrolytic Detector and the Liquid Barretter.* **L. H. Walter.** (Elect. Mag. 2. pp. 384–386, Oct., and pp. 586–588, Dec., 1904.)—A *résumé* of the arguments for and against the heat-effect theory of the asymmetric cell's action. [See also Abstract No. 414 (1905).]

841. *Amperemeter for High Potential Currents.* **H. C. Snook.** (Frank. Inst., Journ. 159. pp. 191–198, March, 1905.)—A d'Arsonval instrument with small condenser placed in shunt to the moving coil and calibrating shunt, and having one pole grounded.

842. *Energy Changes during Magnetisation and Electrification.* **J. Sahulka.** (Elektrotechn. Zeitschr. 26. pp. 116–120, Feb. 2, 1905.)—The author deduces, in a very simple manner, expressions for the energy stored up in every unit of volume of a medium supporting a magnetic or electric field, and gives an account of some simple experiments illustrating the changes of energy during the approach or withdrawal of an armature relatively to a permanent magnet. **F. Emde.** (Ibid., p. 200, Feb. 23.)—Criticisms of the above. A. H.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**843.** *Dilatometric Measurements of Tautomeric Substances.* **F. Giolitti.** (Gazzetta Chim. Ital. 34. 2. pp. 208–220, Oct. 5, 1904. Chem. Univ.-Inst., Rome.)—Pure ethyl acetoacetate, boiling at 181–181·5°, has the specific gravity 1·0286 at 15°, which gives a molecular volume of 126·9; this value remains unchanged on the addition of piperidine or sodium ethoxide. The data obtained by Traube in 1896 give the number 127·9 for the molecular volume of the enolic form, and 132·8 for that of the ketonic modification. Dilatometric measurements show that, between the temperatures −16° and +100°, ethyl acetoacetate does not alter in constitution, or else the change is a uniform one, and the interval of transformation has its extreme limits outside the above range of temperature. With acetylacetone, dilatometric measurements between 70° and 95° indicate an increase in the proportion of the ketonic form, which is in agreement with the observations of Perkin (Chem. Soc., Journ. 61. p. 800, 1892). Acetylacetone chloral shows, however, no contraction in solution, as would be expected from its behaviour towards ferric chloride, and as was shown by Traube in the case of ethyl acetoacetate. Physical and chemical methods of detecting tautomeric forms do not, therefore, agree, the results obtained being often uncertain and sometimes contradictory. T. H. P.

**844.** *Rate of Crystallisation of Plastic Sulphur.* **J. H. Kastle** and **W. P. Kelley.** (Amer. Chem. Journ. 32. pp. 483–503, Nov., 1904. State College of Kentucky, Lexington.)—The results obtained in studying, by specific gravity and dilatometric methods, the rate of change of plastic sulphur into the crystalline variety indicate that this rate varies according to the temperature to which the sulphur is heated before being poured into water, and also according to the temperature at which the product is preserved. The higher the initial temperature to which the sulphur is heated, the slower is the crystallisation; and the higher the temperature at which the sulphur is kept, the more rapid is the change. The presence in the water of ammonia, alcohol, or bromine accelerates crystallisation, whilst that of iodine retards it. Plastic sulphur has no definite melting-point, rise of temperature merely diminishing its viscosity and increasing its tendency to crystallise. Light amber-coloured specimens of plastic sulphur crystallise easily, whilst reddish-brown forms do so more slowly. When placed under tension, sulphur increases in its rapidity of crystallisation. T. H. P.

**845.** *Influence of Light and Heat on the Chlorination and Bromination of Homologues of Thiophen.* **St. Opolski.** (Acad. Sci. Cracovie, Bull. 10. pp. 727–732, Dec., 1904.)—It is well known that chlorine and bromine attack the side chains when they act in the hot or in sunlight on the homologues of benzene. The author finds from experiments on α-methyl and α-ethyl thiophen that the same rule does not apply to homologues of thiophen—which are halogenated in the nucleus whether in the hot or at the ordinary temperature or in presence or absence of sunlight. D. H. J.

**846.** *Composition of Beryl.* **J. H. Pollok.** (Chem. Soc., Journ. 85. pp. 1630–1637, Dec., 1904.)—The anomalous specific heat of glucinum, together with the varying results obtained for the heat of formation of glucinum chloride, and for the ratio of metal to chlorine, suggests the presence in beryl of a body, hitherto unknown, analogous to glucinum, and after considerable investigation, including fractional separations, the various preparations being also spectroscopically examined, the author concludes that the beryl from Limoges does contain at least one new element, which, while resembling glucinum in chemical properties, has a much higher equivalent. This explains the progressive diminution in the accepted atomic weight of the element from 9·28 to 9·05, more and more of the other element being removed, and also accounts for the abnormal specific heat. W. H. Si.

**847.** *Solvent and Fluorescence.* **H. Kauffmann** and **A. Beisswenger.** (Zeitschr. Phys. Chem. 50. pp. 350–354, Dec. 20, 1904. Laborat. f. allg. Chemie, der techn. Hochschule, Stuttgart, July 6, 1904.)—The following table shows the relationship between the dielectric constant of the solvent and the fluorescence of (1) dimethylnaphteurhodin and (2) aminophthalimide :—

I.

| | Dielectric Constant. | Fluorescence. |
|---|---|---|
| Light petroleum | 1·86 | Green |
| Ether | 4·36 | Greenish-yellow |
| Benzene | 2·26 | |
| Ethyl benzoate | 6·04 | Yellow |
| Chloroform | 4·95 | |
| Ethyl oxalate | 8·08 | |
| Pyridine | 12·4 | Orange-yellow |
| Acetone | 20·8 | |
| Ethyl lævulinate | 11·9 | Orange |
| Benzyl cyanide | 15·0 | |
| Ethyl alcohol | 21·7 | |
| Methyl alcohol | 32·5 | Red-orange |

II.

| | Dielectric Constant. | Fluorescence. |
|---|---|---|
| Light petroleum | 1·86 | Blue |
| Ether | 4·36 | |
| Benzene | 2·26 | |
| Ethyl oxalate | 8·08 | Greenish-blue |
| Ethyl benzoate | 6·04 | Greener |
| Acetone | 20·7 | |
| Ethyl lævulinate | 11·9 | |
| Chloroform | 4·95 | Light blue-green |
| Benzyl cyanide | 15·0 | |
| Pyridine | 12·4 | Blue-green |
| Ethyl alcohol | 21·7 | Green |
| Methyl alcohol | 32·5 | Light green |
| Water | 81·7 | Yellow |

There is thus a general relationship between the dielectric constant of the medium and the fluorescence, but the individuality of the fluorescent substance makes itself largely felt. [See also Abstract No. 2553 (1904).] T. M. L.

**848.** *Reduction of Manganese Oxides by Amorphous Boron, and a New Manganese Boride.* **B. du Jassonneix.** (Comptes Rendus, 139. pp. 1209–1211, Dec. 26, 1904.)—Manganese protoxide, sesquioxide, and dioxide are all reduced by boron at the temperature of the blast furnace, a difficultly fused metallic mass being obtained. Heated in a carbon boat in the electric furnace with a current of 400 amps. at 100 volts, mixtures of manganese oxide and boron yield castings containing up to 97 per cent. manganese or up to 20 per cent. boron according to the proportions used. Castings rich in manganese are easily filed, while those containing more boron are harder and more granular. Coarsely powdered, they burn with incandescence in chlorine at a red heat, and the manganese chloride thus formed protects a residue consisting of a definite boride, the analysis of which corresponds to the formula MnB (a brilliant metallic powder ; density 6·2 at 15°). W. H. Si.

**849.** *Heats of Combustion of Atoms and Molecules.* **L. J. Henderson.** (Journ. Phys. Chem. 9. pp. 40–56, Jan., 1905.)—The author tabulates the heats of combustion of a number of organic compounds, by means of which he shows that the heat of reaction of a substitution is dependent not alone upon the nature of the atoms or atom groups which take part directly in the reaction, but also in high degree on the chemical composition of the remainder of the molecule, and on the arrangement of the atoms therein. Thus the same substitution—H by OH—which leads from paraffin hydrocarbon to primary alcohol with a loss of 40 cals. to the heat of combustion of the molecule, when it converts an aldehyde into an acid diminishes the heat of combustion by 72 cals. On the other hand, marked and parallel differences in the heat of formation from the hydrocarbons of primary, secondary, and tertiary alcohols, and of aldehydes and ketones, are to be seen :—

| | | | |
|---|---|---|---|
| Primary alcohols............ | 40 | Aldehydes .............. | 88 |
| Secondary alcohols......... | 42 | Ketones...................... | 92 |
| Tertiary alcohols ......... | 44 | | |

These differences are found to vary in a regular way as the amount of oxygen in the molecule increases. Every atom of a molecule, in a degree dependent upon its position, influences the heat of combustion of every other atom of the molecule, whether or not it is united to that atom. Consequently isomers never possess the same heats of combustion unless the sums of the mutual influences of the atoms in the various molecules are equal. For the valence theory there are two possibilities according to the facts established above. If we assume with Thomsen that the heat of formation of a molecule from the "free atoms" is the sum of the heats of reaction of the various valences, we reach the conclusion that the heats of reaction of the valences are variable because the heats of combustion of the atoms of the molecule are variable. On the other hand, it is possible that the heats of reaction of the valences are constant, and that other relationships exist within the molecule which influence in high degree its heat of combustion. T. H. P.

850. *Hydrodiffusion of Electrolytes.* **L. W. Öholm.** (Zeitschr. Phys. Chem. 50. pp. 309–349, Dec. 20, 1904. Laboratorium für angew. Physik, Helsingfors.)—The diffusion-coefficients are influenced in a marked way by variations both of concentration and of temperature. In all cases in which there is no marked polymerisation, the diffusion-coefficient, which at first decreases with the concentration, reaches a minimum value and then increases again. This is well shown in the accompanying table, in which the values are given in c.cm. per 24 hours at 18° C.

| Norm. | NaCl. | KCl. | LiCl. | KI. | HCl. | $CH_3COOH$. | NaOH. | KOH. |
|---|---|---|---|---|---|---|---|---|
| 0·01 | 1·170 | 1·460 | 1·000 | 1·460 | 2·324 | 0·930 | 1·432 | 1·903 |
| 0·02 | 1·152 | 1·431 | 0·980 | 1·428 | 2·285 | 0·910 | 1·404 | 1·889 |
| 0·05 | 1·139 | 1·409 | 0·971 | 1·412 | 2·251 | 0·895 | 1·386 | 1·872 |
| 0·10 | 1·117 | 1·389 | 0·951 | 1·391 | 2·229 | 0·884 | 1·364 | 1·854 |
| 0·20 | 1·098 | 1·367 | 0·929 | 1·380 | 2·202 | 0·871 | 1·342 | 1·843 |
| 0·50 | 1·077 | 1·345 | 0·919 | 1·372 | 2·188 | 0·856 | 1·310 | 1·841 |
| 1·00 | 1·070 | 1·330 | 0·920 | 1·366 | 2·217 | 0·833 | 1·290 | 1·855 |
| 2·00 | | 1·320 | 0·928 | | | | 1·259 | 1·892 |
| 2·8 | 1·064 | | | 1·434 | | | | |
| 3·6 | | 1·338 | | | | | | |
| 4·2 | | | 0·956 | | | | | |
| 5·5 | 1·065 | | | 1·549 | | | | |

The temperature-coefficients differ for different electrolytes. The smaller the diffusion-coefficient the greater is its temperature-coefficient. Exactly the same relationship holds good with reference to the electrical conductivity and its temperature-coefficient. On comparing the two series of coefficients it is found that the diffusion-coefficients exceed the conductivity-coefficients by about 0·003. As the coefficient of osmotic pressure is 0·0034, it is believed a general law may be stated that "the temperature-coefficient of diffusion of an electrolyte is equal to the sum of the temperature-coefficients of osmotic pressure and electrical conductivity." The following table shows the comparison between (1) the values calculated for the diffusion-coefficients at 18° C. by means of Nernst's formula from the ionic mobilities at that temperature, and (2) the values actually found in the most dilute solutions, 0·01 normal :—

| | Calc. | Obs. | | | Calc. | Obs. | |
|---|---|---|---|---|---|---|---|
| NaCl............... | 1·173 | 1·170 | c.cm./24 hours. | HCl ............... | 2·431 | 2·324 | c.cm./24 hours. |
| KCl ............... | 1·460 | 1·460 | " | $CH_3CO_2H$ ...... | 1·368 | 0·930 | " |
| LiCl ............... | 0·994 | 1·000 | " | KOH ............ | 2·109 | 1·903 | " |
| KT ............... | 1·467 | 1·460 | " | NaOH ........... | 1·558 | 1·432 | " |

There is a very close agreement in the case of the salts, but a marked divergence in the values for the acids and bases. The divergence in the case of acetic acid is easily explained by the fact that even at 0·005-N. the coefficient of ionisation is only 8 per cent., whilst the calculated value for the diffusion-coefficient is that for complete ionisation. There is, however, a difference of 4 per cent. in the case of HCl, and 9 per cent. in the case of NaOH and KOH, which cannot be explained in this way, and it is possible that the divergence is in some way associated with the great mobilities of the hydrogen and hydroxyl ions. The observations on moderately concentrated solutions allow of the calculation of the internal friction $f'$ experienced by the molecule. This is always less than the sum, $f$, of the values for its ions, and the ratio $f'/f$ increases with the electrical conductivity of the salt, as is shown below.

| | 1-norm. | 0·5-norm. | 0·25-norm. | 0·05-norm. | Mean. |
|---|---|---|---|---|---|
| NaCl ......... | 0·83 | 0·90 | 0·96 | 0·83 | 0·88 |
| KCl ......... | 0·92 | 0·95 | 0·98 | 0·98 | 0·96 |
| LiCl ......... | 0·74 | 0·84 | 0·88 | 0·74 | 0·80 |
| KI ............ | 0·86 | 0·93 | 1·01 | 1·18 | 0·99 |
| $C_2H_4O_2$ ...... | 0·82 | 0·80 | 0·79 | 0·77 | 0·79 |

T. M. L.

**851.** *Report of the International Atomic Weight Committee.* (Amer. Chem. Soc., Journ. 27. pp. 1–7, Jan., 1905. Zeitschr. Phys. Chem. 50. pp. 602–607, Jan. 24, 1905. Zeitschr. Anorg. Chem. 43. 1. pp. 1–7, Jan. 16, 1905.)—During the past year new determinations have been made by various investigators of the atomic weights of beryllium, indium, iodine, nitrogen, rubidium, samarium, thorium, and tungsten, and the numbers obtained are here given. On the basis of these determinations the Committee recommend alterations in the atomic weights of indium, iodine, rubidium, and samarium, the new values ($O = 16$) being: $In = 115$, $I = 126·97$, $Rb = 85·5$, and $Sa = 150·3$. In future years the atomic weights will only be given with reference to the standard $O = 16$.

T. H. P.

**852.** *Luminiferous Ether as an Element.* **W. Ackroyd.** (Chem. News, 91. p. 16, Jan. 13, 1905.)—The author has shown (Chem. News, 86. p. 187, 1902) that the distribution in the universe of the elements of a group of the periodic system bears an inverse relation to their atomic weights. Thus the probable distribution of the halogens in the earth in per cent. of its mass is as follows: Chlorine, $4{\cdot}8 \times 10^{-4}$; bromine, $5{\cdot}8 \times 10^{-6}$; iodine, $5{\cdot}8 \times 10^{-8}$; fluorine is probably an exception. According to Ramsay's figures, argon, krypton, and xenon conform to the law; here, again, helium and neon with the lightest atoms are probably exceptions. In general the larger the orbit of a planet the lower is its density, so that the outer and lighter ones may have an excess of those elements wanting in requisite quantity on the earth to make them conform to the law. The low atomic weight recently assigned by Mendeléeff to the luminiferous ether as an element would make it the most plentiful element in the universe. T. H. P.

853. *Temperature Changes on Moistening Powders.* **G. Schwalbe.** (Ann. d. Physik, 16. 1. pp. 32–45, Jan. 26, 1905. Phys. Laborat. d. landwirtschaftl. Hochschule, Berlin, 1903–4.)—Moistening sand or silica with water above 4° causes a rise, with water below 4° a fall, in temperature. A particular proportion of water added gives a maximum rise or fall. The maximum observed was with 10 gm. silica to 20 of water at 16·3°, and corresponded to 6·16 gm.-calories. At 4° there is no change of temperature. A. D.

854. *Physical Properties of Heptoic, Hexahydrobenzoic and Benzoic Acids and their Derivatives.* **J. S. Lumsden.** (Chem. Soc., Journ. 87. pp. 90–98, Feb., 1905.)—From hexahydrobenzoic acid (the simplest acid with a hexamethylene ring) the methyl, ethyl, and propyl esters, the acid chloride and anhydride, and the amide and anilide were prepared and their properties compared with the corresponding compounds of heptoic and benzoic acids. It was found that the properties of hexahydrobenzoic acids and its derivatives were in general intermediate between those of the other two acids—the melting-points, boiling-points, specific gravities, and refractive indices being higher than those of the heptoic and lower than those of the benzoic acid series. The solubilities of the three acids are nearly alike, but the affinity constant of the hexahydro acid is lower than that of benzoic acid, and is like the value of that of an acid of the fatty series. The boiling-points of the hexahydro compounds are regularly 9° higher than the heptoic, and 15° lower than the corresponding benzoic derivatives. A comparison of the molecular volumes showed that a hexamethylene ring and a benzene nucleus have identical volumes, while measurements with a Pulfrich's refractometer proved that the hexamethylene structure has no influence on the refraction of light, but that a benzene nucleus retards light to an amount equal to that due to six hydrogen atoms, thus making the molecular refractions of the corresponding derivatives of benzoic and hexahydrobenzoic acid identical. D. H. J.

855. *A Further Analogy between the Asymmetric Nitrogen and Carbon Atoms.* **H. O. Jones.** (Chem. Soc., Journ. 87. pp. 135–144, Feb., 1905.)—The author contributes to the subject by endeavouring to establish a further analogy between the asymmetric carbon and nitrogen atoms as regards their behaviour during the synthesis of asymmetric compounds. The further analogy has been realised, inasmuch as it has been definitely established (in analogy with carbon compounds) that two compounds are produced when an active tertiary amine combines with an alkyl iodide to form an asymmetric nitrogen compound. The two compounds produced are called respectively

α- and β-compounds—the α-compound being that which has a rotation of the same sign as the amine. The amine chosen was methyl-l-amylaniline, and the alkyl iodides with which it was combined were allyl and benzyl iodides. The α- and β-compounds obtained differ in properties such as melting-point and solubility and in rotatory power, and in chloroform solution are readily transformed one into the other until equilibrium is attained. The two benzyl compounds show only a small difference in solubility, and they are both very labile. The α-phenyl-benzyl-methyl-l-amyl-ammonium iodide melts at 144°–145°, and has $[\alpha]_D$ in chloroform $= 65°$; the β-compound melts at 131°–132°, and has $[\alpha]_D = -18{\cdot}8°$. D. H. J.

**856.** *Influence of Solvents on Rotation of Optically Active Compounds.* VII. *Solution-volume and Rotation of Menthol and Menthyl Tartrates.* **T. S. Patterson and F. Taylor.** (Chem. Soc., Journ. 87. pp. 122–135, Feb., 1905.) The authors have examined the rotation of menthol, l-menthyl d-tartrate, and l-menthyl diacetyl d-tartrate in ethyl alcohol, benzene and nitrobenzene, and have compared the values obtained with the corresponding values for molecular-solution-volume. The results are considered, on the whole, to confirm the suggestion that rotation in solution and molecular-solution-volume are closely related phenomena. For menthol the facts are in complete agreement with theory. With menthyl tartrate the results for alcohol and nitrobenzene are in close agreement, although the relationship between the two variables in benzene is anomalous. Difficulties are met with for menthyl diacetyl tartrate; but although in alcohol and benzene the relationship is not a quantitative one, it is in agreement with theory, in so far as, in both cases, contraction brings about increased rotation. Out of the nine examples studied contraction produces increased rotation in four instances, expansion causes diminished rotation in three instances, contraction accompanies diminished rotation in one case, whilst expansion accompanies increased rotation in another. Thus out of nine observations seven are in accord with the theory, and of the two exceptions one at least is somewhat doubtful. D. H. J.

**857.** *Preparation of Diamonds.* **H. Moissan.** (Comptes Rendus, 140. 277–283, Jan. 30, 1905. Chem. News, 91. pp. 85–86, Feb. 24, 1905.)—As the Cañon Diablo meteorite [see Abstracts Nos. 31 and 521 (1905)] contained diamond in fissures deep in the interior under circumstances which suggested an influence of the iron sulphide, the author fused Swedish iron and sugar carbon in an electric furnace, adding some solid monosulphide of iron to the fused mass. No diamonds were obtained, except when the mass was quickly cooled in water. Addition of carbon silicide had the same effect, but gave less good diamonds. The yield was increased by the additions; the diamonds show cubical and octahedral faces; they crack generally in the course of a few weeks, but can be burned without leaving a residue; the largest had a length of 0·75 mm. The author thus finds his former view confirmed, that graphite results when carbon is volatilised at ordinary pressure without fusion, and that diamonds represent a modification of carbon which had been liquefied at high pressure. H. B.

**858.** *Resistance Furnace for Crucibles.* **F. A. J. FitzGerald.** (Electrochem. Ind., N.Y. 3. pp. 55–58, Feb., 1905.)—Considerable difficulty is found in the design of large electric furnaces owing to the lack of available data. It is of some assistance to study small furnaces that do not take more than 20–50 kw. Here the heat insulation is of especial importance. The arrangement of a 20-kw. furnace supplied with alternating current is detailed. A transformer and regulating device is recommended, so that by the use of a double-throw, two-pole switch the furnace may be supplied with 180 amps. at 110 volts, or 360 amps. at 55 volts. A wooden bench covered with sand, on which are laid bricks so placed as to form two rows of cells or air spaces, is used to support the furnace. The lower cells are empty, but the upper ones are filled with asbestos or, still better, infusorial earth. Details, with sketches, are given of the method of setting up a small furnace for heating crucibles. Amorphous carbon electrodes are advised because graphite electrodes cause a serious loss of heat by conduction. The carbons are cemented with fire-clay, to protect them from oxidation. The shell of the furnace is filled with granular graphitised coke in which the crucible is embedded. When the crucible is in place the outer walls are built round, leaving a space between them and the inner walls. This space is filled with infusorial earth. If the furnace is to be of the permanent type, it is necessary to have a refractory inner lining of silico-carbides. The resistivity of different "resistors" [see Abstract No. 615 (1905)] is discussed at length, and from experiments on small furnaces a design is deduced for a permanent furnace for a number of crucibles.

W. W. H. G.

859. *Calcium.* **J. H. Goodwin.** (Amer. Phil. Soc., Proc. 43. pp. 381–392, Oct.–Dec., 1904. Electrochem. Ind., N.Y. 3. pp. 80–81, Feb., 1905.)—A furnace for the electrolysis of fused $CaCl_2$ is sketched and described. The bottom has a layer of solid chloride cooled by a copper coil. The electrolyte is contained in a graphite vessel into which is lowered a carbon rod forming the kathode. The apparatus was set up inside an empty wind furnace, and the escaping chlorine was drawn from the room. Pure anhydrous $CaCl_2$ was used. It was melted inside a Dixon graphite crucible, and added from time to time to the furnace. Afterwards this method was abandoned, as it was found to introduce Fe, Al, and Si from the binding clay of the crucible, and cold chloride used. The chloride was melted by starting an arc; the average amp.-hour efficiency was 29 per cent., and the average volts 17·7. As the melted calcium was formed at the end of the kathode it could be gradually raised by turning a long screw that carried the electrode-holder. The metal was of 98 per cent. purity. It is thought that no difficulty would be experienced in the working of a much larger furnace, the two essential conditions of success being: (1) the rapid withdrawal of the metal formed to increase the yield and minimise recombination; (2) narrow temperature limits. The bath must be hot enough to deposit the metal molten, not spongy, and cool enough to let it congeal upon the kathode and be raised without breaking off. The solid metal can be worked like other metals, and is much more stable than generally imagined. It can be heated red-hot continuously in a triple Bunsen flame without igniting, but at this temperature its texture is like clay, and it can be easily squeezed apart with tongs. The density at 29·2°C. is 1·5446 (Al is 2·68). For wires of equal weight and length it is second among the metals in the order of electrical conductivity. It is nearly as hard as aluminium, and has a tenacity of 8,710 lbs. per sq. in.

W. W. H. G.

860. *Comparative Physical Properties of Cobalt and Nickel.* **H. Copaux.** (Comptes Rendus, 140. pp. 657–659, March 6, 1905.)—Pure cobalt has hardly

been prepared, except by Tilden for his determinations of the specific heats of metals [see Abstract No. 1389 (1903)]. The author very briefly indicates how the chlorides of Co and Ni are purified and converted into oxalates and reduced to metal. The fusion in a hydrogen atmosphere is more difficult; cobalt easily oxidises, but the oxide does not dissolve in the metal, while the $Ni_2O$ dissolves in the metal (like $Cu_2O$). The resulting ingots of about 50 gm. contained from 1/2000 to 1/4000 of metalloids. The constants are: Density at 15° C., Co 8·8, Ni 8·8; hardness (Mohr) 5·5, 3·5; melting-point 1,530°, 1,470°; specific heat between 20° and 100°: 0·104, 0·108 (Tilden 0·103, 0·108); resistance at 0°, 5·5, 6·4 microhm/cm.$^3$; temperature-coefficient between 0° and 20°: 0·0055, 0·0061; breaking strength: Co 50, Ni 42 kg./mm.$^2$ The breaking strengths are much lower than those of other investigators, but the present note is only a preliminary one. H. B.

861. *Molecular Depression Constant of Para-Azoxyanisole.* **H. M. Smith** and **W. H. McClelland.** (Amer. Chem. Soc., Journ. 26. pp. 1446–1450, Nov., 1904. Univ. of Syracuse.)—It has been previously shown that at 116° *p*-azoxyanisole forms a turbid liquid of fluid crystals which becomes clear and transparent at 134°. Schenck has shown that both these transition points undergo abnormally large depressions, and from the depression of the "clear-turbid" point, using various solutes, he calculated the molecular depression constant, for which he found values ranging from 503 to 859. In the author's investigations, here described, the molecular depression constant of *p*-azoxyanisole, using naphthalene, *α*-nitronaphthalene, anthracene, *o*- and *p*-acetyltoluidines, acetamide, phenetole, and cinnamic acid as solutes, has the mean value 562, whilst when benzil is taken as solute, the mean value is 825. These variations are possibly due to the solubility of the solutes in the fluid crystals formed by *p*-azoxyanisole. T. H. P.

862. *The System: Cupric Chloride, Ammonium Chloride and Water.* **P. A. Meerburg.** (Chemisch Weekblad, 1. pp. 551–559, June 11, 1904.)—The author gives the equilibrium conditions of aqueous solutions containing cupric chloride and ammonium chloride at 30°. A saturated solution of ammonium chloride contains 29·5 per cent. of the salt at 33°, and one of dihydrated cupric chloride, $CuCl_2, 2H_2O$, 43·95 per cent. The only double salt separating from solution is the compound $CuCl_2, 2NH_4Cl, 2H_2O$. The three solubility curves cut one another in two quadruple points. No compound of the composition $CuCl_2, NH_4Cl, H_2O$ exists; such a compound has been described, but it probably consists of a mixture of dihydrated cupric chloride with the double salt mentioned above. The latter is stable between − 11° and + 80°. The ice curve and the dihydrate curve intersect at the cryohydric point, ± − 11°. T. H. P.

863. *Fusion of Dissociating Substances and the Degree of Dissociation in the Fused Mass.* **R. Kremann.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2b. pp. 809–863, July, 1904. Chem. Inst. der Univ. Graz.) — This is an interesting and important theoretical and experimental investigation of the degree of dissociation of binary additive compounds in the fused state. In representing graphically the freezing-points of different mixtures of two components capable of forming an additive compound, the intermediate curve for the equilibrium between this compound and the fused mass is more or less flattened according to the degree of dissociation of the

compound into its single components. The author considers the lowering of the melting-point of the pure compound AB as being due to the presence of the single molecules; and from the laws of mass action and of Raoult, one can calculate the course of the freezing-point curve for different degrees of dissociation of the additive compound, provided the molecular depression is known. The author shows that in the case of great dissociation, addition of one of the components may *raise* the melting-point of the additive compound—a behaviour so far found only when there is formation of solid solutions. The value of the molecular depression could be obtained by the addition of indifferent substances provided these did not act as solvents increasing the dissociation of the additive compound. This dissociating power of the added substance appears to increase with the dielectric constant of the substance. The only way, then, of determining the molecular lowering of the freezing-point is to deduce it from the value of the latent heat of fusion. In this way the author has calculated the degree of dissociation of the additive compounds phenol-aniline, phenol-picric acid, and nitrosodimethylaniline-aniline, and found the values 20, 27, and 15 per cent. respectively. A. F.

864. *Influence of Substitution in the Components of Binary Solutions.* **R. Kremann.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2b. pp. 865–904, July, 1904. Chem. Inst. der Univ. Graz.)—The author has determined the melting-point curves of mixtures of the following pairs of substances; 1:2:4-dinitrotoluene and naphthalene; nitrotoluene and naphthalene; trinitrobenzene and naphthalene; *m*-dinitrobenzene and naphthalene; mononitrobenzene and naphthalene; 2:4:6-trinitrophenol and naphthalene; 2:4-dinitrophenol and naphthalene; *p*- and *o*-nitrophenol and naphthalene; *s*-trinitrobenzene and aniline; *m*-dinitrobenzene and aniline; nitrobenzene and aniline; trinitrotoluene and aniline; dinitrotoluene and aniline; nitrotoluene and aniline. It was found that the melting-point curves of the compounds of the trinitro derivatives, both with aniline and with naphthalene, occupy the greater part of the diagram, and the melting-point curve, further, is comparatively slightly flattened. The analogous dinitro-compounds, however, give much shorter melting-point curves, and these are much flatter than in the case of the trinitro-compounds. An interesting case was met with in dinitrobenzene and naphthalene. In this case the melting-point curve has become so flattened that it is practically a straight line joining the two eutectic points for the compound and each of the components, giving an appearance as if the two components here formed isomorphic mixtures. The mononitro-compounds do not give additive compounds either with aniline or with naphthalene; so that in these cases one obtains the normal two-branch curve. Among the dinitro-compounds, 1:2:4-dinitrotoluene is an exception in not giving a compound with aniline. In general, however, the tendency of two substances to give an additive compound is determined in the first instance by the difference in the positive and negative character of the components; but the position of the substituents has probably also some influence. A. F.

865. *Additive Compounds of Nitrosodimethylaniline.* **R. Kremann.** (Akad. Wiss. Wien, Sitz. Ber. 113. 2b. pp. 905–923, July, 1904. From the Chem. Inst. d. Univ., Graz.)—The author has determined the melting-point of mixtures of nitrosodimethylaniline and *p*-toluidine, *o*-toluidine, *m*-xylidine, β-naphthylamine, phenol; and of nitrosobenzene and aniline, with the

following result: *p*-toluidine and nitrosodimethylaniline give a compound, consisting of 1 mol. of the former to 2 mols. of the latter, melting at 48·5°, which also represents the eutectic point for the compound and nitrosodimethylaniline. The eutectic point for the compound and *p*-toluidine is 28°, with a composition of 27 mols. per cent. of toluidine. In the case of *o*-toluidine and nitrosodimethylaniline, the additive compound has the composition of 2 mols. of nitrosodimethylaniline and 1 mol. of *o*-toluidine, and has a melting-point of about 70°. Nitrosodimethylaniline and *m*-xylidine give two compounds having the composition 3 mols. *m*-xylidine and 1 mol. nitrosodimethylaniline, and 2 mols. *m*-xylidine and 3 mols. nitrosodimethylaniline; the melting-points are 26·0° and 48·0° respectively. β-naphthylamine and nitrosodimethylaniline give a compound consisting of 2 mols. of the former to 3 mols. of the latter, and having the melting-point 86°. The melting-point curve of the compound is rather flat. Phenol and nitrosodimethylaniline give a compound consisting of 2 mols. of the latter to 1 mol. of the former, and melting at 91°. Nitrosobenzene and aniline do not give any additive compound. A. F.

**866.** *Action of Water and Saline Solutions on certain slightly Soluble Phosphates.* **F. K. Cameron** and **L. A. Hurst.** (Amer. Chem. Soc., Journ. 26. pp. 885–913, Aug., 1904. Bureau of Soils, U.S. Dept. of Agriculture, Washington, D.C.)—The solubilities of ferric, aluminic, and calcic phosphates in water have often been determined, but the results obtained by different investigators are contradictory, and in general have been arrived at without taking into account the fact that these phosphates are hydrolysed by water. The authors find that this hydrolysing action is an extremely slow one, so that the final condition of equilibrium is not arrived at, even after shaking the salts with water, for from 30 to 80 days. The free acid accumulates in the solution, while the corresponding base is partly precipitated. The free phosphoric acid tends to increase the solubility of the phosphate, but the base, although present in the solution in smaller proportion, exercises a greater influence in the opposite direction. Hence the addition of larger quantities of water produces a relatively smaller, although actually greater, decomposition of the phosphate. The decrease in the solubility of calcium phosphate due to the presence of calcium chloride or nitrate is in accord with this view, but the increased solubility of aluminium and ferric phosphates produced by aluminium and iron salts respectively does not agree with it, unless it is assumed that the free acid formed by the hydrolysis of the added salts aids the decomposition in these cases. The presence of potassium chloride diminishes the amount of phosphoric acid taken up from ferric, aluminic, or calcium phosphate, but increases the amount of the base going in solution. Sodium nitrate causes a decrease in the amount of dissolved phosphoric acid in the case of ferric or aluminic phosphate, but with calcium phosphate an apparent increase of acid occurs, and an undoubted increase in the quantity of calcium going into solution. With pure aqueous solutions of the phosphates, the acidity appears to be approximately proportional to the quantity of phosphoric acid found in the solution, but in presence of soluble salts no connection can be recognised between the acidity and the dissolved phosphoric acid. Potassium chloride or sulphate or sodium nitrate increases the acidity of the solutions in contact with ferric phosphate, although both potassium chloride and sodium nitrate diminish the amount of phosphoric acid going into solution. No definite relation can be traced between the acidity and the content of iron of the solution; the latter is increased by the presence of potassium chloride. With solutions in contact with calcium phosphate, the acidity is decreased by potassium chloride or sodium nitrate. In both cases the calcium content of the solution is distinctly augmented, while with sodium nitrate the amount of phosphoric acid also rises. Rise of temperature increases the decomposition of the phosphates, both in water and in salt solutions. Since the reactions taking place between the products of hydrolysis and other dissolved substances are very complex, while the final condition of equilibrium cannot be observed, the law of mass action cannot be satisfactorily applied to the results. Some of the observations made cannot be adequately explained on the hypothesis of electrolytic dissociation. T. H. P.

**867.** *Action of Water on the Phosphates of Calcium.* **F. K. Cameron** and **A. Seidell.** (Amer. Chem. Soc., Journ. 26. pp. 1454–1463, Nov., 1904. Bureau of Soils, U.S. Dept. of Agriculture, Washington, D.C.)—When dissolved by water, both tricalcium and monocalcium phosphates undergo a considerable amount of decomposition, but dicalcium phosphate is more stable. With the mono- and tri-calcium phosphates, the extent of the decomposition and the concentration of the resultant solution are found to depend on the relative proportions of phosphate and water used. When calcium sulphate is added, the proportion of phosphoric acid dissolved from tricalcium phosphate is increased; with the monocalcium salt a similar but less increase occurs, but with dicalcium phosphate, a considerable decrease. The amount of phosphoric acid dissolved is in all three cases diminished by the addition of calcium carbonate. With tri- and di-calcium phosphates, carbon dioxide increases the amount of phosphoric acid dissolved, but with the monocalcium salt it is without action in this respect. T. H. P.

**868.** *Supercooled Fusions and Solutions of Sodium Thiosulphate.* **S. W. Young** and **J. P. Mitchell.** (Amer. Chem. Soc., Journ. 26. pp. 1389–1413, Nov., 1904. Stanford Univ., Cal.)—Pentahydrated sodium thiosulphate exists in three different forms: (1) The ordinary commercial or $\alpha$-form; (2) the $\beta$-form, described by Parmentier and Amat (Liebig's Ann. d. Chemie, 98. p. 735, 1894); (3) the $\gamma$-modification, described in the present paper. The $\beta$-form is most readily obtained by heating the $\alpha$-form at 80–100° in a sealed tube for a few minutes and then cooling to —10° or —20°. If a crystal of the $\alpha$-compound is added to the tube containing the $\beta$-form, the whole of the latter becomes converted into the former. The conditions for the formation of the $\gamma$-compound are not accurately known, but it is occasionally obtained in the sealed tube in place of the $\beta$-form. The $\gamma$-modification forms a compact, opaque mass melting at a little above 0° and is quite different from the $\alpha$- and $\beta$-forms which are more or less translucent and melt at about 49° and 32° respectively; these are, however, not true melting-points, since each of the two compounds passes into a saturated solution and a lower hydrate. Four different lower hydrates are described. The *a*-form is obtained when the $\alpha$-pentahydrate is melted and left at the ordinary temperature for a day or two. The *b*-, *c*-, and *d*-forms are produced by the partial fusion of the $\alpha$-, $\gamma$- and $\beta$-pentahydrates respectively. The authors advance a nuclear hypothesis for explaining the phenomena observed in the supercooling of the various forms. They suggest that the nuclei consist of fragments of crystalline aggregates left in the liquid after the breaking down of the crystalline structure, and that, under certain conditions, these unite to form crystalline aggregates capable of starting crystallisation. T. H. P.

**869.** *Composition and Solubility of the Hydrates of Sodium Thiosulphate.* **S. W. Young** and **W. E. Burke.** (Amer. Chem. Soc., Journ. 26. pp. 1413–1422, Nov., 1904. Stanford Univ., Cal.)—The determination of the composition of the various hydrates of sodium thiosulphate is very difficult, owing to the fact that they are metastable with respect to the *α*-form and are rapidly converted into the latter if a trace of it is present [see preceding Abstract]. The *β*-form has been shown by Parmentier and Amat (*loc. cit.*) to be a pentahydrate, and there is little doubt that the *γ*-form has the same composition. The *a*-, *b*-, and *d*- varieties are mono-, di- and tetra-hydrates respectively, but the composition of the *c*-form is uncertain. The solubilities of the *α*-, *β*-, *a*-, *b*-, and *d*-forms at various temperatures are given. T. H. P.

**870.** *Relative Velocities of Ions of Silver Nitrate in Mixtures of Alcohol and Water, and Conductivity of such Mixtures.* **H. C. Jones** and **H. P. Bassett.** (Amer. Chem. Journ. 32. pp. 409–445, Nov., 1904.)—It was found by Jones and Lindsay (Amer. Chem. Journ. 28. p. 329, 1902), who determined the conductivity of potassium iodide, ammonium bromide, strontium iodide, and some other salts in water and in methyl, ethyl, and propyl alcohols, that the conductivity is less in mixtures of the solvents than in either of the solvents alone, this being especially the case with mixtures of methyl alcohol and water. The authors' measurements of the conductivity of silver nitrate in water, methyl alcohol, and mixtures of these two solvents yield similar results. The minimum of conductivity for silver nitrate occurs at 25° in mixtures containing 50–75 per cent. of methyl alcohol and at 0° in mixtures containing about 50 per cent. of methyl alcohol. The conductivity of silver nitrate in water, ethyl alcohol, or mixtures of these, does not exhibit a minimum, either at 25° or 0°, but the curves representing these conductivities indicate that a minimum is approached at 0°. Comparison of the conductivities at 0° with those at 25° shows that the mutual influence of the two solvents on one another diminishes as the temperature rises. Determinations of the relative velocities of the ions at 0° and 25° indicate that, in pure solvents, the velocity diminishes as the temperature rises; in mixtures of solvents, however, exactly the opposite of this is the case. The relative velocities depend greatly on the nature of the solvent, and in mixed solvents are found to vary both with the temperature and with the composition of the mixture. T. H. P.

**871.** *Solubility of the Alkaline Earth Tartrates in Water.* **H. Cantoni** and **Mdlle. Zachoder.** (Bull. Soc. Chim. 31. pp. 1121–1124, Nov. 5, 1904. Univ.-Lab., Geneva.)—The solubilities of calcium tartrate, $CaC_4H_4O_6, 4H_2O$, strontium tartrate, $SrC_4H_4O_6, 3H_2O$, and barium tartrate, $BaC_4H_4O_6$, are given for various temperatures from 0° to 60°. The solubility increases with rise of temperature in each case, and at any one temperature the strontium salt is the most soluble and the barium salt least so. These results lead to the suggestion that in the manufacture of tartaric acid, the potassium tartrate solution should be precipitated by means of a barium salt instead of lime or calcium chloride. The numerical results are given in the form of tables in the original. T. H. P.

**872.** *Reversible Oxidations and Reductions in Solutions.* **E. P. Schoch.** (Amer. Chem. Soc., Journ. 26. pp. 1422–1433, Nov., 1904.)—The investigation here described has for its object the determination of the influence of the concentrations of the components on the equilibrium in solutions of iodine, potassium ferrocyanide, potassium ferricyanide, and potassium iodide in N/20 hydrochloric acid. The reaction probably takes place according to the equation : $2Fe(CN)_6'''' + I_2 \rightleftharpoons 2Fe(CN)_6''' + 2I'$. The potassium ions and the hydrochloric acid play no part in the reaction, but the influence of their concentrations must be known and is determined by a series of e.m.f. measurements. The formula expressing the equilibrium in such solutions at constant temperature is :—

$$\frac{C^4(\text{ferrocyanide}) \times C(\text{free iodide})}{C^2(\text{ferricyanide}) \times C^2(\text{potassium iodide})} = K.$$

That the concentration of the ferrocyanide exists in this equation in the fourth power, and not the second, is shown by both the e.m.f. measurements and the chemical equilibrium determinations. T. H. P.

**873.** *Combustion of Ethylene.* **W. A. Bone** and **R. V. Wheeler.** (Chem. Soc., Journ. 85. pp. 1637–1663, Dec., 1904.)—Extending their researches on combustion to the case of ethylene at 250–400° in borosilicate glass bulbs under pressures varying from 1¾ to 2½ atmospheres, and at 350–500° under reduced pressure in their circulation apparatus, the results obtained completely harmonised with the view that the combustion of a hydrocarbon is essentially a process of hydroxylation, oxygen initially entering the hydrocarbon, and being distributed between the carbon and hydrogen, thus giving rise to unstable bodies which then undergo thermal decomposition into simpler products. It is concluded that (1) no preferential combustion of either carbon or hydrogen occurs when there is insufficient oxygen for complete combustion, any separation of carbon or hydrogen being due to secondary thermal decompositions ; (2) formaldehyde is the chief intermediate oxidation product, its formation being preceded by that of less oxygenated compounds ; (3) the formation of aldehydes precedes that of steam and oxides of carbon ; (4) temperature conditions alone determine the stage in the combustion at which secondary decompositions set in, and (5) there is no separation of carbon or liberation of acetylene, even in the explosive combustion of ethylene, unless insufficient oxygen is present to burn the hydrocarbon to formaldehyde, in which case the excess of ethylene is thermally decomposed, yielding carbon, hydrogen, methane, and traces of acetylene. The initial stage of combustion is believed to involve the direct introduction of oxygen into the hydrocarbon, as the result of collisions between single molecules of ethylene and oxygen. W. H. Si.

**874.** *The Rôle of Diffusion during Catalysis of Colloidal Metals and Similar Substances.* **H. J. S. Sand.** (Roy. Soc., Proc. 74. pp. 356–369, Jan. 23, 1905.)—The author discusses critically the view put forward by Nernst that all chemical reactions taking place on the boundary of two phases proceed to equilibrium practically instantaneously, and that the velocities actually observed are simply those with which diffusion and convection renew the reacting material at the boundary. The main points of the author's discussion are : (1) The experimental results on dependence of reaction velocity on the concentration of the catalyser can only be reconciled with the idea of a heterogeneous reaction by recognising the important part played by convection currents. (2) The experimental results on dependence of reaction velocity on temperature cannot be reconciled with Nernst's hypothesis unless convection plays an important part. (8) If Nernst's hypothesis holds, the reaction velocities found by Bredig (Zeitschr. Phys. Chem. 31. p. 258) must be greater than those calculated for a stationary liquid. The author then deduces a formula for the reaction velocity corresponding to a minimum amount of convection, and on applying it to Bredig's results finds that these contradict Nernst's hypothesis. The author also criticises Nernst's hypothesis from the point of view of thermodynamics, and emphasises the fact that, although in the case of physical processes (solution, &c.) there may be a practically instantaneous production of equilibrium at the interface between two phases, this does not hold for chemical reactions; and although a number of cases are known which conform to Nernst's rule, the latter cannot be considered as holding universally. A. F.

875. *Theory of the Grignard Reaction. New Method of Preparing Organo-magnesium Compounds.* **W. Tschelinzeff.** (Ber. Deut. Chem. Gesell. 37. pp. 4534–4540, Dec. 10, 1904. Chem. Universitätslaborat. Moskau.)—The organo-magnesium compounds discovered by Grignard may be prepared in presence of benzene to which a small amount of ether or anisole is added, or in benzene or toluene solution alone if the temperature is sufficiently high. The ether thus appears to act as a catalytic agent, the reaction occurring in the two stages: $R_2O + R'X = R_2:OR'X$ and the latter $+ Mg = R'.Mg.X + R_2O$. When only a small amount or no ether is employed, the organo-magnesium compound separates without ether of crystallisation. T. H. P.

876. *Influence of Metals on the Hydrolysis of Cane Sugar.* **R. Vondráček.** (Zeitschr. Phys. Chem. 50. pp. 560–566, Jan. 24, 1905. Communicated from the Böhm. Gesell. der Wissensch. in Prag, June 3, 1904.)—Widely varying results have been published regarding the influence of platinum and silver on the inversion of cane sugar. The author finds that when a cane-sugar solution is boiled in a Jena glass vessel with the purest distilled water ($k = 1 \times 10^{-6}$), either with or without the addition of strips of platinum, very slight hydrolysis occurs. When platinum-black is saturated with oxygen from the air it greatly accelerates the inversion, and partially oxidises the sugar to acid. The platinum-black meanwhile becomes inactive, but regains its activity when dried in the air. $H^{\cdot}$-ions are formed during the first few minutes of the action of platinum-black on cane-sugar solution, as may be shown by conductivity determinations and by studying the course of inversion in a solution of cane sugar which has been heated with platinum-black, and the latter then removed by filtration; concordant values are obtained for the inversion constant, which is greater the longer the time of contact of the solution with the platinum-black. The author concludes that metals themselves exert no appreciable influence on the inversion of cane sugar. In cases where action is observed, it appears to be due either to the hydroxides of the metals or to the products of oxidation of the sugar. T. H. P.

877. *Molecular Condition in Solution of Ferrous Oxalate.* **S. E. Sheppard** and **C. E. K. Mees.** (Chem. Soc., Journ. 87. pp. 189–198, Feb., 1905.)—The iron in a developing solution of ferrous oxalate in potassium oxalate is chiefly present as the complex anion $\bar{\mathrm{F}}\mathrm{e}(\bar{\mathrm{C}}_2\mathrm{O}_4)_2$, which is not very stable, and dissociates into solid $FeC_2O_4$ and $\bar{\mathrm{C}}_2\bar{\mathrm{O}}_4$. For equilibrium the amount of ferro-oxalanion in solution must bear a constant ratio to the amount of free

oxalanion, the value for the constant, as found by solubility determinations, being 0·81 at 20°. Spectrophotometric measurements show that the formation of ferrous ions, due to dissociation of the complex into $\overset{++}{\mathrm{Fe}} + 2\,(\overset{--}{\mathrm{C_2O_4}})$, is at moderate dilutions negligibly small. Addition of acid to the solution precipitates ferrous oxalate, by removing free oxalate ions, thus disturbing the equilibrium. The absorption spectrum at three concentrations is given.

W. H. Sı.

878. *Critical Points in Binary Mixtures with Two Liquid Layers.* **H. W. Bakhuis Roozeboom** and **E. H. Büchner.** (Konink. Akad. Wetensch. Amsterdam, Versl. 13. pp. 531–537, Feb. 8, 1905. Proc. 7. pp. 556–562, March 22, 1905.)—This is a consideration of the various variations in the course of three-phase lines with a solid phase. One case was found to occur with diphenyla mine and carbon dioxide. Here two fluid phases are unstable between 31·6° and 38·8° C., but exist above and below. Examples of other cases have been found by Smits [see Abstract No. 3222 (1904)] and others.

H. H. F. H.

879. *Formation of Complexes of Mercury Thiocyanate.* **H. Grossmann.** (Zeitschr. Anorg. Chem. 43. 3. pp. 356–369, Feb. 9, 1905.)—Mercury thiocyanate dissolves in potassium thiocyanate with formation of the complex salt $K_2H_g(SCN)_4$ and separation of metallic mercury. The author has determined the formula of the complex by means of e.m.f. measurements of concentration cells, and finds it the same as that given above. In very dilute solution some trithiocyanate seems also to exist. The constant of complex formation $\left(K = \frac{\text{Complex ion}}{H_g^{\cdot\cdot}\,(SCN)^4}\right($ was found equal to 2·5 × $10^{22}$; it diminishes with rise of temperature. As compared with the bromide, the tendency to complex formation is greater in the case of bromide at higher temperatures; but at lower temperatures the tendency is greater in the case of the thiocyanate.

A. F

880. *Vapour Pressure of Solid Solutions.* **A. Speranski.** (Zeitschr. Phys. Chem. 51. pp. 45–58, Feb. 21, 1905. Universitätslaborat. f. anorg. Chem. Moskau.)—In continuation of his previous work [see Abstract No. 1091 (1904)] the author has determined the vapour pressure of solid solutions of $p$-$C_6H_4ClBr$ and $p$-$C_6H_4Br_2$, and of $p$-$C_6H_4ClBr$ and $p$-$C_6H_4Cl_2$. In the case of solutions of the first pair the vapour pressure of the solutions agrees with that calculated according to the mixture formula $p = \frac{nP_1}{100} + \frac{(100-n)P_2}{100}$. Hence it can be concluded that the isomorphous mixture follows Raoult's law, or that the molecular weight of $p$-$C_6H_4Br_2$ in the solid $p$-$C_6H_4ClBr$ is the same as in the gaseous state. In the case of the second pair of substances, however, the mixture formula only applies to low concentrations; at greater concentrations double molecules of $p$-$C_6H_4Cl_2$ appear.

A. F.

881. *Salt-formation in Solution, especially in the Case of Tautomeric Substances.* **J. W. Brühl** and **H. Schröder.** (Zeitschr. Phys. Chem. 51. pp. 1–18, Feb. 21, 1905. From Verh. des Naturhist.-mediz. Vereins in Heidelberg, 1904.)—The authors have already shown by spectrochemical methods that salt-formation in solution, in the case of the ketonic camphocarbonic ester, involves an instantaneous and complete transformation to the enolic

form [see Abstract No. 628 (1905)]. They now apply the same method to the typical tautomeric substance, acetoacetic ester, and obtain a quite similar result. We may say therefore, generally, that the process of salt-formation in solutions of bodies of the type of acetoacetic ester and its secondary C-alkyl derivatives leads to a sharp enolisation of these pseudo-acidic, tautomeric bodies. Thus a definite end is made to a controversy which has entered into innumerable publications on the subject of tautomerism.

D. H. J.

882. *Solubility of Potassium Chloride, Bromide, and Iodide in Water.* **A. Meusser.** (Zeitschr. Anorg. Chem. 44. 1. pp. 79–80, Feb. 22, 1905.)—The author has investigated the equilibria between the above-mentioned salts and their solutions in water, as well as those between ice and the solutions. The results are given in the following table, in which are given under A the amount of salt (in gm.) in 100 gm. of solution, and under B the amount of salt dissolved by 100 gm. of water. When numbers occur only under B they are interpolated values.

| KCl. | | | KBr. | | | KI. | | |
|---|---|---|---|---|---|---|---|---|
| t°. | A. | B. | t°. | A. | B. | t°. | A. | B. |
| + 18·5 | 25·0 | 33·3 | 10·5 | 38·3 | 62·1 | − 1 | 55·0 | 122·2 |
| 11·5 | 23·8 | 31·2 | 10 | .. | 60·7 | − 5 | 54·5 | 119·8 |
| 10 | .. | 30·8 | 3·5 | 35·7 | 55·5 | − 4 | 54·0 | 117·4 |
| 7·5 | 23·0 | 29·8 | 0 | 34·5 | 52·6 | − 10 | 53·5 | 115·1 |
| 2·5 | 22·2 | 28·4 | − 5 | 33·3 | 50·1 | .. | .. | .. |
| 0 | .. | 27·5 | − 8 | 32·2 | 47·5 | − 14 | 42·7 | 75·8 |
| − 1 | 21·4 | 27·2 | − 11·5 | 31·2 | 45·3 | − 11·5 | 39·3 | 64·7 |
| − 4·5 | 20·6 | 25·9 | − 11 | 31·0 | 44·9 | − 9·5 | 34·0 | 51·5 |
| − 9 | 19·3 | 23·9 | − 10·5 | 29·5 | 41·8 | − 7 | 29·9 | 42·6 |
| − 8·5 | 17·7 | 21·5 | − 10 | .. | 39·7 | − 6 | 25·6 | 34·4 |
| − 8 | 16·7 | 20·0 | − 8·5 | 26·3 | 35·7 | − 5 | 22·5 | 25·7 |
| − 7 | 14·9 | 17·5 | − 8 | 23·8 | 31·2 | | | |
| − 6 | 13·6 | 15·7 | − 6·5 | 20·0 | 25·0 | | | |
| − 5·5 | 12·5 | 14·3 | | | | | | |

The results are reproduced graphically, and from the curves the cryohydric points are seen to be about as follows: KCl, at −9°; KBr, at −11·5°; KI, at − 18·5°.

A. F.

883. *Ionisation in Pyridine Solutions of Inorganic Metallic Salts.* **J. Schroeder.** (Zeitschr. Anorg. Chem. 44. 1. pp. 1–36, Feb. 22, 1905. Abstract of Habilitationsschrift. Chem. Laborat. der Univ., Giessen.)—In spite of numerous physico-chemical investigations it is still difficult to speak with certainty of ionisation in non-aqueous solutions, since the conductivity results do not in general agree with the ebullioscopic data. Assuming chemical reactions to be due to preceding ionisation, the present author endeavours to recognise the presence of ions in pyridine solutions by showing the occurrence of double decompositions in such solutions. I. The behaviour of the following salts in pyridine solution towards anhydrous reagents and towards solutions of anhydrous metallic salts in pyridine was studied: Mercury chloride, bromide, iodide, and cyanide; silver nitrate, sulphate, cyanide, and sulphocyanide; copper chloride; ferric chloride and protochloride. A difference in the behaviour of the metallic salts in pyridine as compared with water was established in the following cases: (1) Mercury salts: (*a*) All the mercury salts investigated combine with two molecules of

pyridine to form double salts of the general formula $HgX_2 . 2 Pyr.$; (*b*) the solubility of the mercury salts in pyridine diminishes in the order chloride, bromide, iodide, cyanide; (*c*) except in the case of mercuric chloride, molecular weight determinations in pyridine give values that are too high; (*d*) as shown by the behaviour towards ammonia, the tendency to the formation of complexes increases in the order chloride, bromide, iodide, cyanide; (*e*) sulphuretted hydrogen precipitates red mercuric sulphide from solutions of mercury salts; the reaction is explicable on the assumption that the black sulphide is the unstable modification and is soluble in pyridine saturated with sulphuretted hydrogen; from this solution the more stable red form separates in a crystalline condition; (*f*) all mercury salts dissolved in pyridine are reduced to metallic mercury by the action of stannous chloride; mercurous salts are not stable in presence of pyridine. (2) Silver salts: (*a*) Molecular weight determinations with pyridine solutions do not establish the existence of ionisation; the values are uniformly higher than those corresponding to the ordinary formulæ; (*b*) free sulphur acts in the hot on all pyridine solutions of silver salts, with formation of silver sulphide; (*c*) in several respects the behaviour in pyridine solutions is different from that in water, the actions in the cases of silver nitrate and sulphate, copper chloride and ferric and ferrous chlorides, being detailed. II. The molecular elevation of the boiling-point of pyridine is 28·4. III. Molecular weight determinations by the boiling-point method give high values in almost all cases. IV. In many cases the reactions in pyridine proceed as in water, and thus support the conclusion that ionisation occurs. The same conclusion may be derived from cases where the reactions are different in the two solvents, if we assume chemical reactions to be an index of ionisation. V. A radical difference of behaviour of salts dissolved in pyridine is observed in cases where water takes an essential part in the reaction as occurring in aqueous solutions. VI. It was often observed that a considerable quantity of water may sometimes be added without affecting the course of the reaction in pyridine. The author suggests a possible association of the water and pyridine. D. H. J.

884. *Desmotropic Compounds.* **O. Dimroth.** (Zeitschr. Elektrochem. 11. pp. 137–139, March 10, 1905.)—The author admits the relevancy of Goldschmidt's criticism [see Abstract No. 637 (1905)]. Concurring in Goldschmidt's view that the reaction is of the first order, he adheres to his opinion that a transposition of the hydrogen atoms in the undissociated state best explains the constitutional changes which he discusses. Reference is made to the controversy between Haber, Bodländer, and Abegg on complex constants and atomic dimensions [see Abstracts Nos. 2781 and 3080 (1904)], and to Lapworth and Hann. H. B.

885. *Microscopic Investigation of Iron Alloys.* **E. Heyn.** (Verein zur Beförderung des Gewerbefleisses, Verh. No. 9. pp. 355–397, Nov., 1904. Communication from the Kgl. Materialprüfungsamt, Gross-Lichterfelde-West.)—The author's report on the microscopical investigation of the alloys prepared by the iron alloys department of the Verein. The investigation was rendered necessary by the fact that the alloys investigated by Osmond contained an amount of manganese which could not be neglected, and the doubt expressed by Arnold and McWilliam [see Abstract No. 136 (1903)] as to the change of structure as a result of quenching. The present investigation confirms Osmond's results in the main and shows Arnold's criticisms to be

unfounded. The series of alloys was prepared so that the treatment was in all cases known, and as nearly similar as possible. This was of assistance in interpreting some new results with nickel steels which might have otherwise been falsely attributed to the nickel. The results are illustrated in thirty-one plates with descriptive matter, for which the original must be consulted.

L. H. W.

886. *Physical Characteristics of Steam Bronzes.* **S. L. Kneass.** (Frank. Inst., Journ. 159. pp. 65–72; Discussion, pp. 72–76, Jan., 1905. Mech. Eng. 15. pp. 128–130, Jan. 28, 1905.)—The number of chemical compounds of copper and tin is a matter of some dispute, but in the foundry, owing to imperfect mixing or other reasons, the binary alloys usually contain more or less eutectic; a eutectic is still more in evidence, and its amount of greater importance in the quaternary alloys of Cu, Sn, Pb, and Zn for steam uses. The homogeneity and freedom from microscopic pinholes depends largely upon design and procedure in the foundry; strength, machining qualities, and fluidity, more especially upon composition. The author gives the results of some experiments bearing upon the conditions affecting homogeneity and density. A small casting made in an iron mould was 7·2 per cent. denser than a similar piece cast in sand. The fracture of the former showed a closer grain, and the tensile strength was higher. No porosity was visible and the quantity of eutectic was reduced. *Discussion:* **G. H. Clamer** said that the eutectic in phosphor bronze of about 80 per cent. Cu, 10 per cent. Sn, and 10 per cent. Pb, was found to contain about 22 per cent. Sn, 2 per cent. Pb, 74 per cent. Cu, and 2 to 3 per cent. P; it is due to the fact that the phosphorus is almost entirely in the eutectic that these alloys are much harder than alloys of otherwise similar composition, but containing no phosphorus. **A. E. Outerbridge, Jr.,** had made many experiments as to the effect of rapid cooling on such alloys as the paper concerns, and attributed the resulting improvement to fluid compression of the internal portion by reason of the tendency of these alloys to expand at the moment of solidification.

F. R.

887. *Brass Alloys, and the Quenching of Bronzes.* **L. Guillet.** (Soc. d'Encouragement, 107. Rev. de Metallurgie, pp. 97–120, Feb., 1905, Comptes Rendus, 140. pp. 307–310, Jan. 30, 1905.)—The former of these two papers gives the microstructure and results of mechanical tests of alloys of lead, tin, aluminium, and manganese respectively, with copper and zinc, both as cast, and after drawing and annealing. In alloys of about 60 per cent. Cu, increasing quantities of Pb diminish the strength slightly, and the elongation and contraction considerably. The brittleness (by Frémont's method) increases, and the hardness (Brinell's figure) is not much affected. The lead remains free microscopically, and surrounds the usual brass grains. Tin increases the strength slightly and diminishes the elongation and contraction rapidly; it causes great brittleness and increased hardness. Micrographically, tin has a similar effect to that of zinc, but 1 per cent. tin is equivalent to 4 per cent. zinc. The results of replacing zinc by manganese are increase of strength, hardness, and (beyond 4 per cent. Mn) brittleness, and an initial increase, and later, decrease, of elongation and contraction. The author states that the structure of these alloys is the same as that of the simple brass containing the same amount of copper. The photomicrograph, however, of the alloy 60 per cent. Cu, 30 per cent. Zn, 10 per cent. Mn does not compare with that of the 60 per cent. Cu brass. For a given copper content, aluminium has the

effect of raising the strength; in low percentages it increases the elongation and toughness, and in higher percentages diminshes these and increases the hardness. In regard to both mechanical properties and microstructure, 3·5 per cent. of zinc could be replaced by 1 per cent. Al. The following results are deduced from experiments in which bronzes containing from 0 to 21 per cent. tin were quenched from temperatures between 300° and 800° C.: the strength of alloys containing less than 8 per cent. tin is increased somewhat by quenching between 400° and 600°. The elongation changes in a very similar way. The breaking stress and elongation of those containing more than 8 per cent. tin increases very rapidly when the quenching temperature exceeds 500°. This result agrees with Heycock and Neville's diagram for these alloys. The higher the percentage of tin, the greater is the improvement of properties which can be produced by quenching from suitable temperatures. The second paper is practically the same as the latter portion of the first. F. R.

888. *Special Constituent in a Quenched Bronze.* **P. Breuil.** (Comptes Rendus, 140. pp. 587-590, Feb. 27, 1905.)—The alloy experimented upon, known as "fortior," contained small proportions of other elements in addition to aluminium and copper; it showed a critical point between 690° and 730° C. Quenched from 550° the structure tended to greater homogeneity than in the untreated material; quenching from 650° and 750° resulted in changing one of the constituents into an acicular form like that of martensite. Upon quenching from still higher temperatures, the structure was practically all of this martensitic type, the needles being parallel throughout any one grain, but varying in direction from grain to grain. The structure is analogous to that of low carbon steels quenched from very high temperatures, and also in some measure to effects of strain. F. R.

889. *Lead-Magnesium Alloys.* **G. Grube.** (Zeitschr. Anorg. Chem. 44. 2. pp. 117-130, March 4, 1905. Inst. f. anorg. Chem. d. Univ. Göttingen.)—Alloys were prepared by melting a solid cylinder of magnesium in a glass tube in an atmosphere of dry hydrogen, the requisite quantity of lead being previously placed on top of the magnesium block, and the whole continuously stirred with an iron rod. Cooling-curves were taken by re-melting the alloys under the same conditions. The results are given in a temperature-concentration diagram, illustrated by photomicrographs. The results prove the existence of only one compound, having the formula $PbMg_2$, and of two eutectic alloys, one consisting of magnesium and the compound, the other of lead and the compound, their freezing-points lying near 460° and 240° respectively. The compound $PbMg_2$ is very readily oxidised, and specimens containing large proportions of this body are difficult to prepare for the microscope; in damp air the product of oxidation is a hydrate of the composition $(PbO, 2MgO) 3H_2O$. If the theory of valencies is applicable to metallic alloys, the compound $PbMg_2$ is derived from quadrivalent lead, corresponding to the methyl- and ethyl-compounds. The properties of this compound determine those of the lead-magnesium alloys; those containing the compound as a secondary body are fairly stable in air, of grey-white colour, and more brittle than pure magnesium; but those alloys containing primary crystals of $PbMg_2$ are very unstable: in contact with moist air they decompose, forming a black powder, and they decompose water in the cold. Like the compound itself, they are steel-grey in colour on freshly-exposed surfaces, and are extremely brittle. W. Ros.

**890.** *Antimony-Bismuth Alloys.* **K. Hüttner** and **G. Tammann.** (Zeitschr. Anorg. Chem. 44. 2. pp. 131–144, March 4, 1905. Inst. f. anorg. Chemie, Göttingen.)—Gautier having found that the melting-point curve of these alloys falls continuously from the melting-point of antimony to that of bismuth, it was supposed that all these alloys would solidify as aggregates of homogeneous mixed crystals; the microscope, however, frequently shows two distinct constituents. The authors consider the question from the standpoint of Roozeboom, and show that if the attainment of equilibrium between the crystals and the mother-liquor were very rapid, or the rate of cooling sufficiently slow, a homogeneous aggregate of one constituent would be formed, and they show experimentally that the nature and amount of the two constituents formed in practice depends upon the rate of cooling. Generally antimony, or an antimony-rich solid solution, begins to crystallise out as soon as the initial freezing-point of the alloy is passed, and the composition of successively-formed layers which are formed as the temperature falls, varies correspondingly. They sum up their conclusions as follows: (1) From alloys rich in antimony, crystals very rich in antimony are first deposited, the entire mass being practically solid at a temperature 50° below the first freezing-point; (2) alloys containing less than 70 per cent. Sb are only completely solid at the freezing-point of bismuth, so that the last portions to crystallise are pure bismuth; (3) mixed crystals of intermediate composition are formed only in very small quantities. A diagram, not of temperature-concentration equilibria, but representing the products found experimentally, is given. The question as to the true mutual solubility of the two metals in all proportions is left open. Photomicrographs of some typical alloys are given in illustration. W. Ros.

**891.** *Structure of Tempered Steel.* **W. Kurbatoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 36. No. 9. pp. 1524–1539, 1904.)—The author, working under le Chatelier's direction, finds that a 4 per cent. solution of nitric acid in amyl alcohol is a satisfactory reagent to distinguish, by the method of colourations, austenite from martensite; the time necessary for the action of the reagent is about 15 min.; the steel must, of course, be examined microscopically or microphotographically. The valuable result just stated is the most important outcome of a detailed examination of the action of the ordinary steel reagents. At the end of the inquiry the author accepts a classification of the constituents of steel into sorbite, austenite, martensite, cementite, pearlite, and ferrite, and to identify these in specimens used for an investigation of the calcination of tempered steel he proposes four reagents: (A) The above-mentioned solution of nitric acid in isoamyl alcohol; (B) a 20 per cent. solution of hydrochloric acid in isoamyl alcohol, to which has been added ⅓ of its volume of a saturated solution of nitraniline in ethyl alcohol; (C) a solution made from 1 part of a 4 per cent. solution of nitric acid in acetic anhydride, 1 part of methyl alcohol, 1 part of ethyl alcohol, 1 part of isoamyl alcohol; (D) a solution made from 3 parts of a saturated solution of nitraniline in acetic anhydride and 1 part of a 4 per cent. solution of nitric acid in isoamyl alcohol. Reaction with these reagents takes place best in small glasses; the piece of steel is placed in the reagent with the polished side upwards. For the reagents A and B the best time is 12–15 min., and for C and D 7–10 min. Generally speaking, only A and C are employed; B and D are confirmatory reagents. The chief value of reagent A depends on its great sensitiveness to very small differences in composition; reagent C is sensitive only in material containing sorbite.

Photomicrographs are given, illustrating the efficiency of the reagents; one of these represents (under a magnification of 650) a steel with 1·9 per cent. carbon, tempered almost at the temperature of fusion and acted on first by reagent A and then by reagent C. It is easy to see the network of lines of cementite (with their accompanying thick masses of troostite) and, in the middle of the photograph, the martensite in which are the crystals of austenite. The sorbite, it is stated, is in reality much better differentiated than it appears to be in the illustration. [This paper and a preceding one [Abstract No. 645 (1905)] appear also in Soc. d'Encouragement, 107. Rev. de Metallurgie, pp. 169–186, March, 1905.] D. H. J.

892. *The Carbon Cell a Gas Element.* **F. Haber** and **L. Bruner.** (Zeitschr. Elektrochem. 10. pp. 697–713, Sept. 9, 1904. From the Chem. Techn. Inst. der techn. Hochschule, Karlsruhe.)—The primary cell of Jacques in which iron and carbon is immersed in fused caustic soda has been investigated with the following conclusions: (1) Iron immersed in fused caustic soda becomes passive owing to an oxide layer being formed; (2) passive iron and bright platinum act as oxygen electrodes if the caustic soda contains manganates [see Abstract No. 652 (1905)]. The oxygen potential with rising temperatures increases. (3) Active iron and attackable carbon become hydrogen elements in fused caustic soda. (4) Alkaline formates and oxalates decompose in caustic potash with formation of alkaline carbonate and hydrogen, the hydrogen alone being productive of e.m.f. (5) Carbon monoxide gives with molten caustic soda, hydrogen productive of e.m.f. (6) The so-called carbon element is an O-H cell (Knallgaskette), of which the oxygen is derived from the air whilst the hydrogen comes from the action of the carbon on the fused substance. W. W. H. G.

893. *Electrolytic Reduction of Carbon Dioxide.* **A. Coehn** and **S. Jahn.** (Ber. Deut. Chem. Gesell. 37. pp. 2836–2842, July 23, 1904. Inst. für phys. Chem. Göttingen.)—Carbon dioxide undergoes electrolytic reduction in aqueous solutions of sodium hydrogen carbonate, or, better, potassium sulphate, but not in sodium carbonate or acid solutions. With most metallic kathodes slight reduction takes place, but with a zinc kathode freshly coated with zinc in a potassium cyanide bath, formic acid is obtained in 50 per cent. yield. When an amalgamated zinc kathode is repeatedly used, its reducing action rapidly increases, and augmented yields of formic acid are obtained. This condition of the kathode is, however, a labile one, and the activity suddenly disappears. With amalgamated copper kathodes, constant yields (45–50 per cent.) of formic acid are obtained after repeated use. The electrolysis of aqueous carbon dioxide solutions also gives formic acid, but in small yield. T. H. P.

894. *Amphoteric Nature of Cacodylic Acid.* **J. Johnston.** (Ber. Deut. Chem. Gesell. 37. pp. 3625–3627, Oct. 22, 1904. University College, Dundee.) —In the determinations made by Zawidzki [Abstract No. 2408 (1904)] of the electrical conductivity of aqueous solutions of cacodylic acid, the water used was not pure enough to allow of any theoretical importance being attached to the results obtained at high dilutions. In the author's measurements of the conductivity of aqueous cacodylic acid solutions here described, water with $K = 0{\cdot}65 \times 10^{-6}$ at 18° was used. The results show that the Ostwald constant increases very considerably with the dilution, the amphoteric nature of the acid being thus indicated. T. H. P.

895. *Electrolytic Reduction of Aromatic Esters.* **C. Mettler.** (Ber. Deut. Chem. Gesell. 37. pp. 3692–3696, Oct. 22, 1904. Chem. Laborat. der Akad. der Wiss., München.)—On reducing a solution of methyl benzoate in a mixture of aqueous sulphuric acid and alcohol in a divided cell by means of lead electrodes at 15–25°, the chief products are benzyl alcohol and benzyl methyl ether. Ethyl benzoate, ethyl *m*-bromobenzoate, and ethyl *o*-chlorobenzoate behave similarly, but with the halogen derivatives the yield of alcohol is greatly diminished. T. H. P.

896. *Electrolytic Estimation of Nitric Acid with a Rotating Kathode.* **L. H. Ingham.** (Amer. Chem. Soc., Journ. 26. pp. 1251–1255, Oct., 1904. John Harrison Lab. of Chemistry.)—In the method proposed by Vortmann in 1890 and found by the author to give satisfactory results, the solution of the nitrate is mixed with a known volume of standard sulphuric acid and a definite amount of copper sulphate, and the mixture submitted to electrolysis The reduction of the nitrate yields ammonia, which neutralises a portion of the acid, so that the amount of nitric acid can be readily calculated from the residual acid (including that of the copper sulphate). The conditions for successful working of the process are given. T. H. P.

897. *Estimation and Separation of Gold Electrolytically.* **S. P. Miller.** (Amer. Chem. Soc., Journ. 26. pp. 1255–1269, Oct., 1904. John Harrison Lab. of Chemistry.)—The authoress gives the conditions under which gold may be satisfactorily deposited electrolytically from its solutions (1) in potassium cyanide, (2) in presence of phosphoric acid, and (3) in sodium sulphide solution. In potassium cyanide solution the separation of gold and iron can be carried out, but it is not possible to separate gold from cadmium, silver, and mercury. The separation of gold from cadmium, iron, zinc, cobalt, and nickel can be effected in phosphate solution, while in sodium sulphide solution, it is possible to separate gold from arsenic, molybdenum, and tungsten. T. H. P.

898. *Electrolytic Iron.* **S. Maximowitsch.** (Zeitschr. Elektrochem. 11. pp. 52–53, Jan. 20, 1905. Kaiserl. Laborat. zur Anfertigung der Staatspapiere St. Petersburg, Dec., 1904.)—A long series of experiments have shown that a solution of iron carbonate is a suitable electrolyte for obtaining good deposits of iron. The bath is prepared as follows: A glass cell of 6 litres' capacity is filled with a solution of 20 per cent. crystallised ferrous sulphate and 5 per cent. of magnesium sulphate in which electrodes of 20 × 15 cm. are immersed. The anode is of iron, the kathode of copper lightly silvered and iodised. To the solution 25 gm. of $NaHCO_3$ is added, when a yellow scum is formed on the surface, which after three days changes to a brilliant brown film. The original turbid solution simultaneously brightens with the separation of a voluminous precipitate. Twice a week 20–25 gm. of $NaHCO_3$ are added to the bath, making 300 gm. in the course of four weeks during which the electrolysis is continued. The amount of dissolved $Fe(CO_3H)_2$ in a test was 0·23 per cent. The current density used must lie between 0·3–0·6 amp. (per sq. dm. ?). Excellent iron is obtained with a tenacity of 5,180 kg. per sq, cm.; it is at the same time quite flexible. W. W. H. G.

899. *Electrolytic Oxidation of Hydrocarbons of the Benzene Series. I. Hydrocarbons Containing the Methyl Group.* **H. D. Law** and **F. M. Perkin.** (Faraday Soc., Trans. 1. pp. 31–40; Discussion, pp. 40–41, Jan., 1905.—Experiments on anodic oxidation of hydrocarbons dissolved in acetone. The

electrolyte was dilute sulphuric acid. Aldehydes are produced, but the yields are small. Toluene gave 7 per cent. benzaldehyde, *m*-xylene 10–15 per cent. *m*-toluene aldehyde, *o*-xylene 28–30 per cent. *o*-toluene aldehyde, *p*-xylene 25–35 per cent. *p*-toluene aldehyde. Experiments were also made with pseudocumene and mesitylene. F. G. D.

900. *Plating Sheet Zinc with Nickel.* **Brandely.** (Electrochem. Ind., N.Y. 2. pp. 499–500, Dec., 1904. Journal de l'Electrolyse, Oct. 15, 1904.)—The zinc, carefully cleaned and polished, is coated with copper and then plated with nickel in a bath, containing nickel ammonium sulphate 600 gm., ammonium sulphate 100 gm., boracic acid 250 gm., in 10 litres of water, by currents of 1·2 ampere/cm.$^2$. The nickel is to be deposited on one side of the zinc only. H. B.

901. *Note on the Electrolytic Recovery of Tin.* **F. Gelstharp.** (Faraday Soc., Trans. 1. pp. 111–112; Discussion, pp. 114–117, Jan., 1905. Chem. News, 91. p. 1, Jan. 6, 1905. Electrochem. Ind., N.Y. 3. pp. 62–63; Discussion, p. 67, Feb., 1905.)—The author records an observation that a piece of tin-plate employed as an anode in a bath of pure sodium hydrate was unattacked by the current until the current had been reversed for a moment, after which the tin was stripped quickly and efficiently. The author ascribes the phenomenon to a thin coat of tin oxide which is unattacked by the alkali and which is reduced by the hydrogen on reversing the current. It was further observed that if a piece of bright iron is placed in contact with the plate no reversing is needed. J. L. F. V.

902. *Electrolysis of Cobalt and Nickel Tartrates.* **J. E. Root.** (Journ. Phys. Chem. 9. pp. 1–12, Jan., 1905.)—The apparent decomposition value for cobalt in alkaline tartrate solutions is 1·75, for nickel 2·8 volts [see Abstract No. 1561 (1904)]. In the presence of cobalt, the decomposition voltage for nickel is lowered, however, so that the complete analytical separation takes days; cobaltic oxides are formed. But the bulk of cobalt can be precipitated free of nickel, and there is no difficulty in the electrolytic determination of cobalt, in the absence of nickel, as oxide $Co_2O_3 . 3H_2O$, Coehn's formula being confirmed. The author electrolyses sulphates and nitrates without diaphrams. H. B.

903. *Colloidal Ferric Hydroxide Obtained by Electro-dialysis.* **J. Tribot** and **H. Chrétien.** (Comptes Rendus, 140. pp. 144–146, Jan. 16, 1905.)—On dialysing a solution of ferric hydroxide in ferric chloride a colloidal ferric hydroxide is obtained which always contains appreciable proportions of chlorine. If, however, an electric current of 1 amp. is simultaneously passed through the dialyser so that the kathode dips into the inner vessel, the velocity of dialysis increases, and the chlorine-content of the colloid is diminished. The colloidal hydroxide prepared in this way exhibits similar properties to that obtained by Graham, but differs from this in its greater accelerating action on the transformation of albumen into albumoses in alkaline solution. T. H. P.

904. *Electrolytic Preparation of Ceric Ammonium Nitrate.* **G. Plancher** and **G. Barbieri.** (Accad. Lincei, Atti, 14. pp. 119–120, Jan. 22, 1905.)—The authors have found that ceric ammonium nitrate (which is important for the separation of cerium from lanthanum, neodymium, praseodymium, and samarium, and also for the preparation of incandescent mantles) can be

obtained by the electrolytic oxidation of the corresponding cerous salt. A current of 0·1–0·2 amp. per sq. cm. of anode suffices, and the yield is quantitative. D. H. J.

**905.** *Relations between Kathode Potential and Electrolytic Reduction.* **J. Tafel** and **K. Naumann.** (Zeitschr. Phys. Chem. 50. pp. 713–752, Feb. 7, 1905. Chem. Inst. d. Univ., Würzburg, Oct., 1904.)—While Haber and Russ [see Abstracts Nos. 2068 and 2071 (1904)] have chiefly studied the electrolytic reduction of nitro-compounds which are easily reduced, the authors investigate the difficult electrolytic reduction of caffeine and succinimide which appears to be inseparable from the liberation of hydrogen. In solutions of sulphuric acid, only three metals effect this reduction, Cd, Pb, Hg, and these metals are distinguished by high "Ueberspannung." Even lead fails when the Ueberspannung is reduced. The lower limit for the Pb kathode-potential $\epsilon$ is for caffeine reduction 1·6 or 1·7 volts, with currents of from 0·04 to 0·125 amp./cm.$^2$ It is remarkable that the addition of caffeine to the acid has itself an effect on the kathode potential $\epsilon$, lowering it so much with tin kathodes that no reduction ensues. With lead kathodes the first effect is to raise the $\epsilon$; further addition of caffeine diminishes it; with mercury kathodes there is always diminution. Succinimide, on the other hand, raises the potentials of Pb and Hg. Caffeine is more rapidly reduced with Hg than with Pb kathodes, succinimide more rapidly with Pb. The surface condition of the lead does not appear to have any importance provided the electrolytes be pure; in this respect the previous experiments (when traces of copper were present) of 1900 by Tafel and Schmitz, otherwise confirmed, are corrected. When caffeine is reduced with Hg kathodes the Hg potential behaves as if the hydrogen generation were alone of influence; $\epsilon = a + b \log(100 - N)$, where N is the efficiency of the caffeine reduction. A similar logarithmic relation holds for Pb kathodes, and these results would be in accordance with Haber's views on the electrolytic reduction of nitro-compounds (without hydrogen liberation), if the portion of the current concerned in the reduction be alone regarded. The formation of hydrogen gas and the reduction seem to be co-ordinated, irreversible kathode phenomena, and the kathode potential due to the forcible accumulation on the kathode of hydrogen in some form—gaseous under high pressure, atomic, or as compound. H. B.

**906.** *The Aluminium Rectifier.* **S. B. Charters.** (Journ. Phys. Chem. 9. pp. 110–148, Feb., 1905. Part of thesis presented to the Faculty of Sibley College, June, 1904.)—The author combines an aluminium coil as anode, through which water is flowing, with a lead plate. When the direct-current pressure is slowly raised, by steps of 5 volts, up to 500 volts, the hydroxide film forming on the Al stops the current more and more, so that only a small leakage current remains which grows stronger with each step, until a critical voltage is reached. On further raising the pressure the film gives way at some point, and sparking and rapid perforation of the aluminium tube may follow. The higher the pressure, the thicker the Al film. The critical pressure is 55 volts in sulphuric acid, 220 volts in di-sodium phosphate, 300 volts and more in citric acid. The alternating current rectifier of the author consists of four U-tubes, connected by rubber tubing; experiments were made with currents of 110 volts and 60 cycles in phosphoric acid (critical pressure 300 volts), and also with a mixture of phosphoric and sulphuric acids; organic acids would be unsuitable. The phosphoric acid rectifiers behave satisfactorily, the current, voltage, and energy efficiencies being respectively 76, 80 to 85, and 20 to 80 per cent., with a power-factor of 90 per cent. The voltage loss is due to a counter-electromotive force of 50 or 60 volts. The author believes with Taylor and Inglis (Phil. Mag. 5. pp. 301–313, March, 1903) that the aluminium hydroxide film is impermeable to $SO_4''$, and also to $Al^{\cdots}$ ions, but permeable to $H^{\cdot}$ ions, and can hence at once respond to current reversals. H. B.

**907.** *Polarisation with Kathodic Hydrogen Liberation.* **J. Tafel.** (Zeitschr. Phys. Chem. 50 pp. 641–712, Feb. 7, 1905. Chem. Inst. d. Univ. Würzburg, Oct., 1904.)—Referring to the researches of Nernst and Caspari on "Ueberspannung" [see Abstracts Nos. 257 and 2287 (1900)] and to his own work [Abstract No. 1869 (1904)], the author determined kathode potentials in dilute sulphuric acid during a stationary state of electrolysis, by means of platinum anodes, under visible hydrogen evolution; very delicate measurements were therefore excluded. The kathode potential $\epsilon$ rises with rising current density, and should therefore be stated for a definite current intensity. Some metals, Pb, Cd, Ag, Cu, show two states of polarisation when the anode acid has access, an elevation and a depression of the $\epsilon$, the two differing for Cd by about 0·5 volt. The elevation passes into the depression state during electrolysis, gradually or suddenly; the depression into the elevation state, suddenly with Pb and Cd, when the kathode is polarised, the anode acid being occluded. The depression appears to be due to an alteration of the kathode surface, caused by some anode effect, but not by an oxidation of the sulphuric acid (ozone or hydrogen peroxide); some Pt may be dissolved and re-deposited; the author and B. Emmert are further investigating this point. The primary influence of the surface condition is small, in the case of Pb at any rate, except that the potentials of spongy kathodes are less stable than those of smooth kathodes. The "Ueberspannung" series of the author differs from others; at the lower end is Pt, 0·07, and next to it—leaving a great gap—Ni, 0·74; at the upper end polished lead and mercury, both 1·30. Only platinised platinum and mercury give a constant $\epsilon$ for constant current; with the other metals the $\epsilon$ rises slowly. When the anode acid has no access, the temporary polarisation maximum is with constant current almost instantaneously reached with Hg and Pb, more slowly with Cd, Sn, Bi, in the course of hours with Cu, Ni, and Au, and hardly at all with smooth Pt. For Hg (and also Pb and Cd), the $\epsilon$ depends upon the current according to $\epsilon = a + b \log J$, where $a$ and $b$ are constants. As these metals show the greatest "Ueberspannung," the thickness of the gaseous film (Haber) would not appear to be of primary importance. Rising temperature lowers the $\epsilon$, the acid concentration has little influence. H. B.

**908.** *Electrolysis of Organic Acids by Alternating Currents.* **A. Brochet and J. Petit.** (Comptes Rendus, 140. pp. 442–444, Feb. 13, 1905.)—The experiments were made with formic, oxalic, and acetic acids and their salts with currents of 42 periods and about 1 amp./cm.$^2$ by means of strip electrodes of platinum; sulphuric acid is added to the electrolytes, which must be cooled. Formic acid yields hydrogen with a current efficiency of 55 per cent., and oxygen 9 per cent. Potassium formate yields chiefly hydrogen, very little oxygen and carbon dioxide; the electrodes become coated with carbon, which does not adhere to them. Barium formate behaves similarly; the deposit on the electrodes consists of carbon and barium carbonate. Alternating currents thus give the same products as direct currents, and the efficiency is higher in the former case. **H. B.**

909. *Blue Aluminium Compounds on Aluminium Anodes.* **F. Fischer.** (Zeitschr. Anorg. Chem. 43. 3. pp. 341–347, Feb. 9, 1905. I Chem. Inst. d. Univ., Berlin.)—The author places an aluminium tube, 8 mm. in diam., as anode in sulphuric acid, and surrounds it, some distance off, by a tubular helical lead kathode; water circulates through both electrodes. With good cooling a very hard blue substance forms on the anode; the upper layers are only grey in colour and soft. A similar compound is obtained in sulphates, not in electrolytes of chlorides, phosphates, &c. The blue compound seems to be a basic aluminium sulphate containing only a little of the Si and hardly any of the Fe of the commercial aluminium. It dissolves in acids under generation of hydrogen, is not a homogeneous substance, and the blue colour disappears on heating, and is not observed when the anode is not cooled. Blue Al compounds, possibly responsible for the blue colour of ultramarine, have been mentioned by C. Winkler and by Blackmore. With K. Norden [see Abstract No. 260 (1900)] the author considers that the action of electrolytic valve-cells depends upon the formation of a skin of $Al(OH)_3$, more or less bound by sulphuric acid, on the aluminium. [See also Abstracts Nos. 177 and 319 (1905).] **H. B.**

910. *Behaviour of Anodes of Iridium, Platinum, and Rhodium in Dilute Sulphuric Acid.* **J. B. Westhaver.** (Zeitschr. Phys. Chem. 51. pp. 65–94, Feb. 21, 1905.)—The author electrolyses 0·1 normal sulphuric acid with gradually increased voltages, waiting each time—sometimes for days—until constant values were attained, in H cells or in diaphragm cells, the diaphragm consisting of a clay partition or a special vessel. The electrodes are sheets, wires, smooth, platinised, and iridised, and also, to minimise gas occlusion, mirror electrodes, metal films burned into glass. Although some sulphuric acid was especially prepared by Bodenstein from sulphur dioxide and oxygen by the platinum contact method, and all dust excluded, some reducing agent appears to be formed during electrolysis, even when ozone is passed through the acid. The electrolyte is agitated, and hydrogen and oxygen are bubbled through it. Iridium proves, on the whole, least subject to polarisation; with small current densities, platinum is least polarised. Mirror electrodes of iridium give most rapidly stationary conditions, and iridised electrodes are recommended for conductivity determinations with the aid of the alternating-current and telephone method. The decomposition curves for platinum and platinised electrodes show considerable hysteresis. The electromotive force of the $H_2 - O_2$ couple in sulphuric acid at ordinary temperature is 1·06 volts; with platinised platinum electrodes, the e.m.f. would rise to 1·1 volts, but only momentarily; when completely immersed, the oxygen electrode did not give more than 0·9 volt. The so-called characteristic "Knickpunkte" of the decomposition at 1·08 and 1·67 volts were not observed by the author, who considers that such Knickpunkte shift with the scale adopted and the sensitiveness of the instruments; he finds, however, a Knickpunkt at 1·45 volts, possibly connected with the formation of bubbles, for Pt and Ir. **H. B.**

911. *Electrolytic Dissolution of Platinum in Sulphuric Acid.* **A. Brochet** and **J. Petit.** (Comptes Rendus, 140. pp. 655–657, March 6, 1905.)—With regard to the dissolution of platinum in cyanides [see Abstract No. 919 (1905)], the authors add that an alloy is formed, and that from 10 to 15 times

more hydrogen is evolved than would correspond to the dissolved platinum; this would indicate an oxidation of the cyanide. In sulphuric acid it is not the alternating current which dissolves the platinum. In the absence of oxidising agents, the platinum is dissolved at the anode, and re-precipitated at the kathode. The presence of oxidising agents does not favour the dissolution, but it prevents the kathodic reduction. When a direct current is superposed on the alternating current, the two anode effects are combined, and the total action is that of an oscillating direct current. The authors differ in this interpretation from Ruer. [See Abstract No. 214 (1904).]
H. B.

912. *Flow of Electric Current between Liquids and Gases.* **K. Klüpfel.** (Ann. d. Physik, 16. 3. pp. 574–583, March 14, 1905. Extracts from Dissertation at Marburg, Nov. 14, 1903.)—A current of high-tension electricity was generated by a Toepler machine the terminals of which were connected, the one with a Pt plate immersed in an aqueous solution of KI, the other with a Pt wire with its point at from 1 to 6·5 mm. above the solution; in the circuit a Kohlrausch iodine-voltameter was included. If the point were the anode, very much more iodine was disengaged in the solution than in the voltameter, and the more the higher the point, owing, doubtless, to the formation of ozone, &c.; but if this was minimised by a strong current of H being led over the surface, and by further covering the surface with a mica diaphragm, the iodine disengaged at the limiting surface of the solution and the gas above it was in accordance with Faraday's quantitative law. Similarly, if the point were the kathode, the amount of KOH disengaged at the surface corresponded with the law. The author explains the excess of I disengaged in the first case as due to collisions between the ions above the liquid which cause greater ionisation; and he discusses papers by Warburg and Gray in the light of this view. He also examined the gas that surrounds an electrode dipping into an electrolytic liquid when a current of great density passes between it and the liquid; using a 40 per cent. solution of $H_2SO_4$ and collecting in a eudiometer tube the gases formed, he found much more gas than corresponded to Faraday's law, but, considering with Wehnelt that the excess was Knallgas (doubtless due to ionic collisions, as above), and removing it by the passage of sparks from a coil, he obtained a residue which asymptotically approximated to the amount demanded by the law, and this whether the electrode were anode or kathode. He noted, too, a strong development of ultra-violet light in the gaseous envelope of the electrode. R. E. B.

913. *Electrolytic Oxidation of Aliphatic Aldehydes.* **H. D. Law.** (Chem. Soc., Journ. 87. pp. 198–206, Feb., 1905.)—The chief products of the action of anodic oxygen on formaldehyde, acetaldehyde, propaldehyde, and isobutaldehyde are found to be the corresponding acids, which, if the oxidation is carried far enough, are converted into carbon dioxide. With formaldehyde a considerable amount of carbon monoxide also results, and acetaldehyde and propaldehyde both yield small quantities of hydrocarbon and carbon monoxide, the formation of the latter being regarded as favouring the assumption of quadrivalent oxygen. An attempt is now being made to oxidise the hydrocarbons.
W. H. Si.

914. *Electrolytic Separation of Metals.* **W. McA. Johnson.** (Electrochem. Ind., N.Y. 3. p. 94, March, 1905.)—Two general principles applying to the separation of metals are noted. (1) To separate a negative metal from

a more positive one it is only necessary to have the concentration of the hydrogen as "ionic hydrogen" strong enough so that no positive metal can be deposited at ordinary current densities. The presence of 2–3 per cent. of mineral acid will effect this by keeping the electrode potential low. This is done in the case of Fe and Cu, and Ni and Cu. The hydrogen ions act like a safety valve, and prevent the kathode potential rising above a certain limit, providing that the circulation of the electrolyte is sufficiently vigorous to neutralise the concentration changes. (2) If the anode consists of 90 per cent. of M+ and 10 per cent. M— the kathode will be quite pure at low rates of dissolution. If the current density be increased, the less positive metal will be dissolved and precipitated on the kathode in considerable amount; but if the electrolyte be so circulated that before much M— reaches the kathode it is removed to another system, then it is possible to remove M— from the process. W. W. H. G.

## REFERENCES.

915. *Action of Barium Amalgam on Solutions of Sodium and Potassium Salts.* **G. McP. Smith.** (Journ. Phys. Chem. 9. pp. 13–35, Jan., 1905.)—The author replies to the criticisms of Fernekes [see Abstract No. 252 (1905)] on his previous work on this subject. T. H. P.

916. *Evidence of the Formation of Complexes in the Case of Acids, with the Help of Isohydry.* **R. Hofmann.** (Zeitschr. Phys. Chem. 51. pp. 59–64, Feb. 21, 1905. II. Phys. Inst., Wien, Sept., 1904.)—By the method employed formerly [see Abstract No. 678 (1904)] the author finds that sulphuric acid and iodic acid do not form complexes in solutions several times normal. Chromic acid and iodic acid, however, form a complex. It must also be concluded that sulphuric acid and phosphoric acid, and phosphoric acid and hydrobromic acid form complexes. A. F.

917. *Electrolysis of Potassium Acetate.* **F. Foerster** and **A. Piguet.** (Zeitschr. Elektrochem. 10. pp. 924–925, Dec. 2, 1904.)—In answer to Hofer and Moest's critique [see Abstract No. 325 (1905)], the authors admit that their formula $CH_3CO_2H + 4O' \longrightarrow 2CO_2 + 2H_2O$ should be replaced by $CH_3CO_2' + OH' + 2\oplus \longrightarrow CH_3OH + CO_2$, and agree that the discharge of the anions of the fatty acids is the most simple—though, they think, not a necessary—assumption. H. B.

918. *Electrolysis by Alternating Currents. Passive State of Metals.* **M. le Blanc.** (Zeitschr. Elektrochem. 11. pp. 8–10, Jan. 6, 1905. Communication from the Inst. für Physikal. Chemie d. Techn. Hochschule, Karlsruhe.)—This paper is a reply to Brochet and Petit, and Sackur. The author adheres to his opinion that, for researches on the velocity of ionic reactions [see Abstract No. 1233 (1904)] direct currents and a revolving commutator are more suitable than sinusoidal alternating currents. [Brochet, Abstract No. 327 (1905).] The condition for dissolution by alternating currents is not that a complex compound be formed (Brochet), but that direct currents should not effect electrolysis. As regards the passivity of metals [Sackur, Abstract No. 326 (1905)], the author points out that the rate of the formation of the ions signifies quite in general the rate of the transformation of the solid metal into the ionic state, and not merely the reception of a charge; the process may take place in several stages. H. B.

919. *Action of Potassium Cyanide on Different Metals.* **A. Brochet** and **J. Petit.** (Chem. News, 91. p. 67, Feb. 10, 1905. Bull. Soc. Chim., Series 3, vol. 31, No. 23.)—Solutions of KCN attack Al and Mg energetically; Cu and Zn, especially when hot, under generation of hydrogen; and the other metals hardly at all in the cold. Attention is drawn to the action on Pt [see Abstract No. 327 (1905).] H. B.